Application of a New Point Measurement Device to Quantify Groundwater-Surface Water Interactions at the Interface

Cremeans, Mackenzie; Devlin, Rick ; McKnight, Ursula S.; Bjerg, Poul Løgstrup

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Ecohydrology on the Edge:

ecology-hydrology-human interactions in a changing world

6th International Multidisciplinary Conference on Hydrology and Ecology

University of Birmingham
18-23 June 2017

United Nations Educational, Scientific and Cultural Organization

UNESCO Chair on Water Science, University of Birmingham, United Kingdom

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About HydroEco2017

Ecohydrology as a scientific discipline has been emerging from the need to address the interactions and feedbacks between ecological, hydrological, geomorphological and atmospheric processes, and aims to understand and predict fast changing aquatic-terrestrial environments. Over the last decade, the scientific discipline of Ecohydrology has seen rapid technological and conceptual developments.

The highly dynamic and often non-linear behaviour of ecohydrological processes pose unique challenges in understanding, monitoring and conserving freshwater ecosystems. Complex process interactions often cause ecohydrological processes to show pronounced temporal dynamics and exhibit marked non-linear behaviour in response to environmental change. Such behaviour manifests itself by the occurrence of distinct thresholds, tipping points or hot moments, periods of enhanced (re)activity and rapid regime shifts; but may also be associated with pronounced spatial heterogeneity, producing locations of enhanced activity or hot spots.

The 6th International Multidisciplinary Conference on: Hydrology and Ecology will focus on “Ecohydrology on the edge: ecology-hydrology-human interactions in a changing world”

Contents

Contents

Local Organisers

Professor Stefan Krause

Prof Stefan Krause is a Professor of Ecohydrology & Biogeochemistry. His research investigates the impacts of global environmental change on hydrological fluxes, biogeochemical cycling and ecohydrological feedback functions in complex landscapes with coupled groundwater-surface water systems.

Professor David Hannah

Prof David Hannah is a physical geographer with interdisciplinary research interests focusing on complementary themes within hydroclimatology (interface between hydrology-climatology). He is the Director of Research for the College of Life and Environmental Sciences at University of Birmingham.

Professor Jonathan Sadler

Professor Sadler is a biogeographer and ecologist who focuses on species population and assemblage dynamics in urban and riparian environments. His research involves interdisciplinary science using a combination of detailed field studies and field experimentation. His work emphasizes the links between environmental variability and species responses, with particular emphasis on urbanisation and hydrological disturbance.

Professor Alexander Milner

Professor Alexander Milner is responsible for the Masters degree in River Environmental Management at University of Birmingham. His research involves river ecosystems in alpine and Arctic environments and he has long term studies in Glacier Bay National Park and Denali National Park in Alaska. Other studies have included how water sources are changing in glacially influenced river systems with climate change and how these changes alter ecological structure and function.

Dr Nicholas Kettridge

Dr Nick Kettridge specializes in characterizing the ecohydrological resilience of ecosystems to both natural and anthropogenic disturbance. Much of his research focuses on peatlands; understanding the processes that control the provision of key ecosystem services within these environments, and quantifying their response to changing climatic conditions and extreme events such as fire and drought.

Professor Greg Sambrook Smith

Over the last 20 years Dr Sambrook Smith has been investigating the linkages between river processes and sedimentology at scales ranging from individual pores within a river bed up to km-long bars in some of the World's largest rivers. Research aims to generate new, generic and quantitative understanding of how rivers function across these scales.

Dr Mark Ledger

Mark is an ecologist researching environmental change in freshwaters. His research group is focused on understanding how environmental stressors and climate change, especially extreme climatic events such as floods, droughts and heat waves, affect the structure and functioning of aquatic ecosystems. Mark currently leads several NERC-funded research projects and supports a number of doctoral researchers and postdoctoral fellows. He also works actively with a growing network of colleagues in the UK and overseas.

Dr Chris Bradley

Chris has been a lecturer in Geography and Environmental Science at the University of Birmingham from 1994 and became Senior Lecturer from 2007.

Dr Anne Van Loon

Dr Anne Van Loon is a Senior Lecturer in Physical Geography at University of Birmingham. Dr Van Loon is a catchment hydrologist and hydrogeologist working on drought. She studies the relationship between climate, landscape/ geology, and hydrological extremes and its variation around the world. She is especially interested in the influence of storage in groundwater, human activities, and cold conditions (snow and glaciers) on the development of drought.

Dr Sally Rangecroft

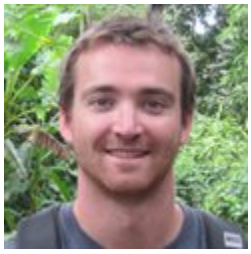
Dr Sally Rangecroft is a Research Fellow at University of Birmingham. Sally is a physical geographer with experience and interest in interdisciplinary research on water resources, water security and climate change. Her current research with Dr Anne Van Loon is aiming to add the human dimension into drought research, a Rubicon project funded by the Dutch Science Foundation NOW.

Dr Philip Blaen

Phillip Blaen is a Research Fellow at the University of Birmingham. His research involves investigating drivers of water and nutrient transport through river networks with a particular focus on the hydrology of forest ecosystems.

Dr Kieran Khamis

Kieran Khamis is a Research Associate at University of Birmingham. Kieran is a hydroecologist with specialist knowledge of alpine river systems. His current research is focused on the development of a real time, fluorescence-based monitoring system for surface waters.



Dr Steve Dugdale

Steve Dugdale is a Research Fellow at University of Birmingham. Steve is a physical geographer interested in the application of remote sensing to understand the links between physical stream processes and fluvial ecology. His current research focuses on quantifying the mechanisms driving temperature patterns in rivers and their influence on aquatic ecosystems.

Dr. Feng Mao

Feng's main research interest is in the intersection of environmental science, technology and policy. His research mainly addresses three themes: (1) hydroecology and ecosystem services, (2) evidence-based environmental policies and adaptive management, and (3) environmental data collection via sensor networks, data analysis and visualisation.

International Advisory Board

Susana Bernal - Spanish National Research Council

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Sami Ullah - Keele University

Anne Van Loon - University of Birmingham

Jesus Gomez Velez - New Mexico Institute of Mining and Technology

Conference Sessions

S1 Non-linear dynamics (thresholds and tipping points) of ecosystem responses, resilience and adaptation
Convener: Susana Bernal

S2 Dynamic process interactions at ecohydrological interfaces across spatial and temporal scales
Convener: Gilles Pinay, David Hannah, Stefan Krause

S3 Multi-stressor interactions and impacts on ecohydrological process dynamics
Convener: Ursula McKnight

S4 AQUATIC ECOLOGY - Quantitative analysis of interactions between hydrological and biological processes
Convener: Paul Wood

S5 Linking hydroecology and ecohydraulics: towards a better understanding of interactions between ecosystems, hydraulics and hydrological processes
Convener: Valérie Ouellet, Stephen Dugdale

S6 Novel approaches in plant, soil, water atmosphere interactions
Convener: Josie Geris

S7 Ecohydrology in restoration practice - ecosystem management, engineering and society
Convener: Bob Grabowski

S8 New experimental and modelling methods for investigating groundwater - surface water interactions
Convener: Adam Ward, Jesus Gomez

S9 Ecohydrology interactions with emerging pollutants (incl. microplastics, engineered nanoparticles, pharmaceuticals)
Convener: Joerg Lewandowski, Iseult Lynch, Jonas Schaper

S10 Novel sensing and monitoring techniques in hydroecology - from 'omics' to distributed sensor networks and real-time ecohydrology
Convener: Laurent Pfister

S11 Forest Ecohydrology
Convener: Phil Blaen

S12 Hydroecological process dynamics and nutrient flows in wetlands and riparian zones
Convener: Sami, Nick Kettridge, Thomas Hein

S13 Cold region Ecohydrology, including alpine ecosystems and cold zones
Convener: Alexander Milner, Stefan Krause

S14 Ecohydrology of urban landscapes under change
Convener: Anne Jefferson

S15 Dryland and drought ecohydrology
Convener: Anne Van Loon, Tom Pugh

Conference Programme

Sunday 18 June 2017

17:00-.... Ice Breaker at the University of Birmingham Lapworth Museum of Geology (http://www.birmingham.ac.uk/facilities/lapworth-museum/index.aspx)

Registration and conference material pick-up will be possible from15:30-17:00 at the Lapworth Musuem

Monday 19 June 2017

Registration and conference material pick-up from 07:30-17:00

Posters on display from 08:00 (remain on display until Thursday 20 June, 19:00)

Presenters of today please upload their **ORAL PRESENTATIONS** at the respective rooms in the morning

08:30-09:00	***ROOM A*** **Conference opening, Welcome addresses** *[Stefan Krause (University of Birmingham), Tim Softley (Pro-Vice Chancellor Research, University of Birmingham)]*		
	ROOM A ***Convener:*** *Stefan Krause (University of Birmingham)*		
09:00-09:30	**Keynote: Application of Ecohydrology to achieving the 2015-2030 Sustainable Development Goals** *[Michael McClain (Unesco-IHE, Delft)]*		
09:30-10:00	**Keynote: The role of agent-based models in faunal ecohydrologic analysis** *[Steve Gorelick (Stanford University)]*		
10:00-10:30	**Keynote: Multi-scale connectivity of landscapes and riverscapes as a control on the ecohydrology of Atlantic salmon nursery streams** *[Chris Soulsby (University of Aberdeen]*		
10:30-11:00	**Coffee Break**		
	ROOM A ***Session 8: New Experimental and Modelling Methods for Investigating Groundwater - Surface Water Interactions*** ***Conveners:*** *Adam Ward (Indiana University), Jesus Gomez-Velez (New Mexico Tech)*		***ROOM B*** ***Session 12: Hydroecological process dynamics and nutrient flows in wetlands and riparian zones*** ***Conveners:*** *Nick Kettridge (University of Birmingham), Sami Ullah (University of Birmingham)*
11:00-11:15	**Hydrologic Connectivity of River Corridors** *[Jud Harvey, (U.S. Geological Survey) . Laurel Larson (UC Berkeley)* ***INVITED****]*	11:00-11:15	**Large-scale nutrient retention, loading and management effects over whole wetlandscapes** *[Georgia Destouni (Stockholm University)* ***INVITED]***

11:15-11:30	**Hydrological and microbial controls on oxygen consumption along bed forms** *[Shai Arnon (Ben-Gurion University of the Negev)]*	11:15-11:30	**Effects of increased atmospheric reactive nitrogen deposition upon rates of biological nitrogen fixation in peatbogs** *[Ernesto Saiz Val (Keele University)]*
11:30-11:45	**How old is your streambed?** *[Michael Stewardson (The University of Melbourne)]*	11:30-11:45	**An evaluation of spatio-temporal CO2 flux gradients across the soil-pond profile in an upland Irish blanket peatland** *[Mariya Radomski (Dublin Institute of Technology)]*
11:45-12:00	**Identification of pattern and fluxes of groundwater-stream water exchange in a heterogeneous sand-bed stream by fibre optic distributed temperature sensing** *[Jaime Gaona (Leibniz Institut of Freshwater Ecology and Inland Fisheries / Freie Universität Berlin)]*	11:45-12:00	**Numerical Simulation of Surface water and Groundwater Interaction in the Wetlands** *[Schradh Saenton (Chiang Mai University)]*
12:00-12:15	**BEST Engineered Hyporheic Zones: Enhanced Hyporheic Exchange and Resazurin and Nitrogen Cycling in Constructed Stream Experiments** *[Andrea Portmann (Colorado School of Mines)]*	12:00-12:15	**Coupling hydrology and biogeochemistry in riparian wetlands: An interdisciplinary approach** *[Stefan Durejka (University of Bayreuth)]*
12:15-12:30	**Quantifying Lake – Groundwater Interactions in an Inland Lake: Field Experiments and Numerical Modeling** *[Mantha Phanikumar (Michigan State University)]*	12:15-12:30	**Integration of remotely sensed data with the WETSPA hydrological model for improved ET estimations in wetland ecosystem** *Joanna Suliga (Vrije Universiteit Brussel)*
12:30-13:30	**Lunch Break**		
	ROOM A		***ROOM B***
	Session 8: New Experimental and Modelling Methods for Investigating Groundwater - Surface Water Interactions		***Session 11: Forest Ecohydrology***
	Conveners: *Adam Ward (Indiana University), Jesus Gomez-Velez (New Mexico Tech)*		***Conveners:*** *Phil Blaen (University of Birmingham)*
13:30-13:45	**Integrating theory, experimentation, and modeling for multiscale assessment of hyporheic exchange** *[Aaron Packman (Northwestern University)* ***INVITED]***	13:30-13:45	**Governing forestry effects on mercury - Who owns the problem?** *[Kevin Bishop (Swedish University of Agricultural Sciences)* ***INVITED***]
13:45-14:00	**How river-groundwater connectivity controls nutrient dynamics in a mesoscale catchment** *[Jan Fleckenstein (Helmholtz Center for Environmental Research, UFZ)]*	13:45-14:00	**Riparian Landscape Fragmentation, Reforestation Efforts, and the Regulation of Headwater Stream Network Thermal Regimes** {Valerie Ouellet (Stroud Water research centre)]
14:00-14:15	**A new approach to using streambed thermal signatures to charaterise spatio-temporal patterns of transitory groundwater-surface water interactions** *[Mark Cuthbert (University College London)]*	14:00-14:15	**Forests, Fish and Freshwater Pearl Mussels – Ongoing Research at the Hydrology-Ecology Interface** [Nadeem Shah (Forest Research)
14:15-14:30	**Dynamic network expansion, contraction, and connectivity in the river corridor of mountain stream networks** *[Adam Ward (Indiana University)]*	14:15-14:30	**Forest transpiration: Resolving root water uptake patterns in space and time** [Theresa Blume (German Research Centre for Geosciences)]
14:30-14:45	**Development of compartment model on primary and secondary production at**	14:30-14:45	**A global review on hydrological responses to forest change across multiple spatial**

	pool and riffle structure in Japanese river middle reach *[Masatoshi Denda (Public works research institute)]*		**scales** [Mingfang Zhang (University of Electronic Science and Technology of China]]
14:45-15:00	**Evaluation of Groundwater for Sustainable Development in Siwa Oasis, Egypt Using Integrated Remote Sensing Data and GIS** *[Safaa Hassan (Data Reception, Analysis and Receiving Station Affairs Division)]*	14:45-15:00	
15:00-15:30	**Coffee Break**		
	ROOM A		
15:30-16:00	**Inauguration UNESCO chair in Water Sciences** *[Anil Mishra (UNESCO Paris)]* *[David Hannah, (University of Birmingham)]*		
16:00-17:00	**Poster pop-up presentations**		
17:00 – 18:30	***POSTER AREA*** **Poster/ drink reception**		

Tuesday 20 June 2017

Registration and conference material pick-up from 07:30-17:00

Presenters of today please upload their **ORAL PRESENTATIONS** at the respective rooms in the morning

	ROOM A ***Convener:*** *Stefan Krause (University of Birmingham)*		
09:00-09:30	**Keynote: Plants as physical engineers of river ecosystems** *[Angela Gurnell, Queen Mary (University London)]*		
09:30-10:00	**Keynote: Understanding the fifty shades of brown: The need to combine long-term monitoring with process-based research across spatial and temporal scales** *[Hjalmar Laudon (Swedish University of Agricultural Sciences, Umeå, Sweden)]*		
10:00-10:30	**Keynote: Data-driven research in a nonstationary world: a top-down approach to understanding critical interactions and scales from the catchment to the planet** *[Laurel Larson (University of California, Berkeley)]*		
10:30-11:00	**Coffee Break**		
	ROOM A ***Session 2: Dynamic process interactions at ecohydrological interfaces acrossspatial and temporal scales*** ***Conveners:*** *Gilles Pinay (OSUR-CNRS-University of Rennes 1), David Hannah (University of Birmingham), Stefan Krause (University of Birmingham)*		***ROOM B*** ***Session 4: AQUATIC ECOLOGY - Quantitative analysis of interactions between hydrological and biological processes*** ***Conveners:*** *Paul Wood (Loughborough University)*
11:00-11:15	**From continuous to discontinuous: Spatial stream flow intermittency dominates carbon quantity and quality in a headwater mountain stream** [Jay Zarnetske/Steven Plont (Michigan	11:00-11:15	**Repurposing flow-ecology tools for environmental flows assessment in cold regions** *[Wendy Monk (Canadian Rivers Institute, University of New Brunswick)* ***INVITED]***

	State University), ***INVITED***]		
11:15-11:30	**Reconciling drainage basin and landscape approaches to improve water quality** [Gilles Pinay, (OSUR-CNRS-University of Rennes)]	11:15-11:30	**Impacts of Hydrodynamics on the Behavioural Response of the Endangered Freshwater Pearl Mussel (Margaritifera margaritifera)** *[Rhian Thomas (University of Glasgow)]*
11:30-11:45	**Small ecosystem engineers are major drivers of aquatic sediment respiration** *[Victor Baranov, Joerg Lewandowski (Leibniz-Institute of Freshwater Ecology (IGB))]*	11:30-11:45	**Life cycle assessment of water consumption impacts from hydropower reservoirs on aquatic biodiversity** *[Martin Dorber (Norwegian University of Science and Technology)]*
11:45-12:00	**Mesocosm experiment reveals potential changes of nutrient processing and stream metabolism due to drought scenarios in Alpine streams** *[Astrid Harjung (Universitat de Barcelona)]*	11:45-12:00	**Habitat suitability modelling of Pengba fish of Loktak Lake in Northeast India** *[Khwairakpam Eliza (Indian Institute of Technology Delhi)]*
12:00-12:15	**Gravel bars are sites of increased CO2 outgassing in headwater streams** [Kyle Boodoo (University of Vienna)]	12:00-12:15	**Assessing the evidence of macroinvertebrate response to fine sediment in rivers** *[Morwenna Mckenzie (Coventry University)]*
12:15-12:30	**Effects of helophytes on solute transport dynamics along subsurface flowpaths in artificial flumes** *[Myrto Nikolakopoulou, (Naturalea – University of Barcelona)]*	12:15-12:30	**Hydrological and thermal effects of hydropeaking on early life stages of salmonids: A modelling approach for implementing mitigation strategies** *[Roser Casas-Mulet, (The University of Melbourne / Water Research Institute, Cardiff University)]*
12:30-13:30	**Lunch Break**		
	ROOM A ***Session 2: Dynamic process interactions at ecohydrological interfaces acrossspatial and temporal scales*** ***Conveners:*** *Gilles Pinay (OSUR-CNRS-University of Rennes 1), David Hannah (University of Birmingham), Stefan Krause (University of Birmingham)*		***ROOM B*** ***Session 4: AQUATIC ECOLOGY - Quantitative analysis of interactions between hydrological and biological processes*** ***Conveners:*** *Paul Wood (Loughborough University)*
13:30-13:45	**Ecohydrological Interfaces as hotspots of biogeochemical cycling** *[Stefan Krause, (University of Birmingham)]*	11:00-11:15	***Natural or designer environmental flows for a changing world?*** *[Mike Acreman, (Centre for Ecology & Hydrology) **INVITED**]*
13:45-14:00	**Stable spatial structure and strong temporal synchrony of water quality in stream networks** *[Ben Abbott, (Michigan State University)]*	11:15-11:30	**Benthic Biofilm Structure Alters Fine Particle Deposition and Resuspension in Streams** *[Kevin Roche, (Northwestern University)]*
14:00-14:15	**Runoff generation processes inferred from surface water network dynamics** *[Marta Antonelli (Luxembourg Institute of Science and Technology (LIST))]*	11:30-11:45	**Exploring the microhabitat preferences of the fish assemblage present in a small Tanzanian river** *[Francisco Martinez-Capel, (Universitat Politecnica de Valencia)]*
14:15-14:30	**Topographical versus geological controls of groundwater residence times to streams** *[Jean-Raynald de Dreuzy (CNRS, University of Rennes 1)]*	11:45-12:00	**Assessing the role of vertical flux on sediments ecology and community distribution in rivers: a holistic approach** *[Ignacio Peralta-Maraver, (University of Roehampton)]*
14:30-14:45	**Hydrologic Controls on Hyporheic Oxygen Dynamics around In-stream Features** *[Tanja Brandt, (Helmholtz Centre for Environmental Research – UFZ)]*	12:00-12:15	**Understanding and predicting juvenile salmon abundance at large spatial scales using landscape proxies for habitat.** *[Iain Malcolm, (Marine Scotland Science Freshwater Fisheries Laboratory)]*
14:45-15:00	**Streambed heterogeneity drives microbial metabolic activity through residence time** *[Paul Romeijn, (University of Birmingham)]*	12:15-12:30	**Combined effects of climate change and dam construction on riverine ecosystems** *[Mijke van Oorschot, (Deltares)]*
15:00-15:30	**Coffee break**		

	ROOM A ***Session 13: Cold region Ecohydrology, including alpine ecosystems and cold zones*** ***Conveners:*** *Alexander Milner (University of Birmingham), Stefan Krause (University of Birmingham)*		***ROOM B*** ***Session 9: Ecohydrology interactions with emerging pollutants (incl. microplastics, engineered nanoparticles, pharmaceuticals)*** ***Conveners:*** *Joerg Lewandowski (Leibniz-Institute of Freshwater Ecology and Inland Fisheries), Iseult Lynch (University of Birmingham)*
15:30-15:45	**Permafrost degradation impacts to stream ecosystems in polar regions** *[Michael Gooseff (University of Colorado) **INVITED**]*	15:30-15:45	**Organic micropollutants in surface water systems – a quick overview** *[Michael Radke (Institute of Hygiene and Environment) **INVITED**]*
15:45-16:00	**The role and response of flows through fens in the Tanana Flats lowland of interior Alaska to permafrost thaw** *[Thomas Douglas (Cold Regions Research and Engineering Laboratory)]*	15:45-16:00	**Heavy Metal-Microbe Interactions in Aquatic Systems: Challenges and Prospects for the Safeguard of Health and Environment** [Ved Pal Singh (University of Delhi)]
16:00-16:15	**Hotspots and hot moments; the control of structural heterogeneity on the thermal regime of the peatland soil-atmosphere interface** *[Rhoswen Leonard (University of Birmingham)]*	16:00-16:15	**Will climate-related changes in runoff be an enhancement or impairment for riparian vegetation?** *[Dagmar Kappel Andersen (Aarhus University)]*
16:15-16:30	**Insights into the effects of patchy ice layers on water balance heterogeneity in peatlands** *[Simon Dixon (University of Birmingham)]*	16:15-16:30	**Acute effects of Ag2S NP in fluvial biofilms before and after ozonation process** *[Berta Bonet (University of Birmingham)]*
16:30-16:45	**Revisiting the Flood Pulse Concept - How peatland hydrology influences spatial vegetation community distributions in a natural floodplain** *[Floris Keizer (Copernicus Institute of Sustainable Development, Utrecht University)]*	16:30-16:45	**TBC** *[Teresa Fernandes (Heriot Watt University)]*
16:45-17:00	**Climate change and glacier shrinkage in Arctic and alpine streams; effects on physiochemical variables and biotic communities.** *[Alexander Milner, Kieran Khamis (University of Birmingham)]*	16:45-17:00	**Biogeochemical and hydrological constraints on concentration-discharge curves** *[Florentina Moatar (Université François-Rabelais de Tours)]*
17:00 – 18:30	***POSTER AREA*** **Poster/ drink reception**		
19:00 – 24:00	**CONFERENCE DINNER**		

Wednesday 21 June 2017

Registration and conference material pick-up from 07:30-17:00

Presenters of today please upload their **ORAL PRESENTATIONS** at the respective rooms in the morning

08:30-09:00	Poster pop-up presentations
09:00-09:30	***ROOM A*** ***Convener:*** *Stefan Krause (University of Birmingham)* **Keynote: The effects of thermokarst on landscape change and permafrost carbon release in northern ecosystems**

	[Merrit Turetsky (University of Guelph)]		
09:30-10:00	**Keynote: The influence of groundwater on agroecosystems and vice versa** *[Steven Loheide (University of Wisconsin)]*		
10:00-10:30	**Keynote: Nancy Grimm**		
10:30-11:00	**Coffee Break**		
	ROOM A		***ROOM B***
	Session 3: Multi-stressor interactions and impacts on ecohydrological process dynamics		***Session 10: Novel sensing and monitoring techniques in hydroecology - from 'omics' to distributed sensor networks and real-time ecohydrology***
	Conveners: *Ursula McKnight (Technical University of Denmark)*		***Conveners:*** *Laurent Pfister (Luxemberg Institute of Science and Technology)*
11:00-11:15	**Abundant benthic microbial mats in harsh stream environments: underlying hydrologic, biogeochemical and ecological controls** *[Diane McKnight (Institute of Arctic and Alpine Research, University of Colorado Boulder)* ***INVITED****]*	11:00-11:15	**Water isotopes provide insights into the hydrologic functioning of sustainable drainage systems for stormwater management** *[Anne Jefferson (Kent State University)]*
11:15-11:30	**Drivers of microbial metabolic activity, biogeochemical cycling and associated greenhouse gas production in streambed sediments** *[Sophie Comer-Warner (University of Birmingham)]*	11:15-11:30	**Development of a continental-scale database of streamflow and stream temperature for aquatic ecosystem studies** *[Darren Ficklin (Indiana University)]*
11:30-11:45	**Altered oxygen dynamics in the sub-surface environment under urbanization: consequence for nutrient pathways.** *[Carolyn Oldham (The University of Western Australia)]*	11:30-11:45	**Unpicking dissolved organic matter dynamics in an urban river system using time series analysis** *[Kieran Khamis (University of Birmingham)]*
11:45-12:00	**Climate change impact on riverine nitrous oxide emissions across biomes** *[Alessandra Marzadri (Center for Ecohydraulics Research, University of Idaho)]*	11:45-12:00	**Quantification of biogeochemical activity in streams using continuous monitoring of dissolved gases** *[Camille Vautier (Université de Rennes-1)]*
12:00-12:15	**Intersecting threats of climate change and river basin fragmentation in the Central Great Plains of the United States,** *[Melinda Daniels (Stroud Water Research Center)]*	12:00-12:15	**Data Integration - Hydrology, Water Quality and Biological Observations** *[Frank Schlaeger (KISTERS AG (private sector))]*
12:15-12:30	**Re-evaluating multi-stressor interactions: novel insights advancing stream ecosystem impact assessments** *[Ursula McKnight (Department of Environmental Engineering)]*	12:15-12:30	
12:30-13:30	**Lunch Break**		
	ROOM A		***ROOM B***
	Session 3: Multi-stressor interactions and impacts on ecohydrological process dynamics		***Session 10: Novel sensing and monitoring techniques in hydroecology - from 'omics' to distributed sensor networks and real-time ecohydrology***
	Conveners: *Ursula McKnight (Technical University of Denmark)*		***Conveners:*** *Laurent Pfister (Luxemberg Institute of Science and Technology)*
13:30-13:45	**Impact of overland flow, macropore flow, and matrix flow on N and P dynamics in artificially drained lanscapes of the US Midwest.**	13:30-13:45	**Detecting the invisible water drain: forest evaporation with Distributed Temperature Sensing (DTS)** *[Miriam Coenders-Gerrits (Delft University of*

	[Philippe Vidon (SUNY-ESF)]		*Technology)* ***INVITED****]*
13:45-14:00	**Multiple stressors affect ecological stream communities involved in organic matter processing** *[Jes Rasmussen (Aarhus University)]*	13:45-14:00	**Monitoring Water Quality on a Continuous Basis: how good are the new sensors?** *[François Birgand (NC State University)]*
14:00-14:15	**Evaluating stream water quality and ecological integrity in the context of impairment and conservation within the Delaware River watershed** *[Marie Kurz,(Academy of Natural Sciences of Drexel University)]*	14:00-14:15	**Can a riparian vegetation model be spatially validated?** *[Alicia García-Arias (Universitat Politècnica de Valencia - Research Institute of Water and Environmental Engineering)]*
14:15-14:30	**The state of ponds of Manipur Valley in Northeast India in view of changing time** *[Kshetrimayum Krishnakanta Singh (Assam University, India)]*	14:15-14:30	**A conceptual model of groundwater dissolved organic nitrogen based on a machine learning method and sensitivity analysis** *[Benya Wang (The University of Western Australia)]*
14:30-14:45	**Characterisation of river temperature heterogeneity at the regional scale: influence of vegetation, small weirs and stream-aquifer exchanges** *[Pierre Loicq (Université de Tours (France))]*	14:30-14:45	**Characterising river temperature heterogeneity using UAV-based thermal infrared remote sensing and deterministic river temperature models** *[Stephen Dugdale (University of Birmingham)]*
14:45-15:00		14:45-15:00	**Application of a New Point Measurement Device to Quantify Groundwater-Surface Water Interactions at the Interface** *[Mackenzie Cremeans (University of Kansas)]*
15:00-15:30	**Coffee break**		
	ROOM A		***ROOM B***
	Session 14: Ecohydrology of urban landscapes under change		***Session 15: Dryland and drought ecohydrology***
	Conveners: *Anne Jefferson* (*Kent State University)*		***Conveners:*** *Anne Van Loon (University of Birmingham), Tom Pugh (University of Birmingham)*
15:30-15:45	**Urban Stormwater Infrastructure at City, Regional, and National Scales** *[Rebecca Hale (Idaho State University)]*	15:30-15:45	**Plants under drought stress: shifts of hydraulic plant strategies and ecohydrological processes in response to climate** *[Britta Tietjen (Freie Universität Berlin, Institute of Biology)* ***INVITED****]*
15:45-16:00	**Impacts of stormwater runoff on the soil and water quality of an urban prairie nature preserve** *[Liliana Hernandez (Northwestern University)]*	15:45-16:00	**Water and vapor transfer in vadose zone of Gobi desert and riparian zone in the hyper arid environment, experiment and simulation** *[Chaoyang Du, (Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences)]*
16:00-16:15	**Integrated hydrological assessment of an urban nature preserve using a high-frequency sensor network** *[Vivien Rivera (Northwestern University)]*	16:00-16:15	**Ecological Rehydration Index - An empirical tool to determine the water source and status of dryland riparian trees developed in the Pilbara region of Western Australia** *[Duncan Storey, (AQ2 Pty Ltd)]*
16:15-16:30	**Effects of green infrastructure on stream base flow and groundwater recharge** *[Aditi Bhaskar (Colorado State University)]* ***INVITED***	16:15-16:30	**Loss of habitat and connectivity during drought** [Cédric Laizé, (Centre for Ecology and Hydrology)]
16:30-16:45		16:30-16:45	**Temporary streams in temperate zones: recognizing and monitoring the ecological quality of transitional aquatic-terrestrial ecosystems** *[Rachel Stubbington (Nottingham Trent University)* ***INVITED****]*
16:45-17:00		16:45-17:00	

17:00 – 18:30	***POSTER AREA*** **Poster/ drink reception**

Thursday 22 June 2017

Registration and conference material pick-up from 07:30-17:00

Presenters of today please upload their **ORAL PRESENTATIONS** at the respective rooms in the morning

08:30-09:00	Poster pop-up presentations		
	ROOM A ***Convener:*** *Stefan Krause (University of Birmingham)*		
09:00-09:30	**Keynote: TBC** *[Glenn Watts]*		
09:30-10:00	**Keynote: Compartmentalization of the terrestrial water cycle** *[Jeff McDonnell (University of Saskatchewan)]*		
10:00-10:30	**Keynote: New potentiometric chloride sensors provide high resolution information on physical transport and exchange processes in streams** *[Keith Smettem (Murdoch University and University of Western Australia)]*		
10:30-11:00	**Coffee Break**		
	ROOM A ***Session 1: Non-linear dynamics (thresholds and tipping points) of ecosystem responses, resilience and adaptation*** ***Conveners:*** *Susana Bernal (CEAB-CSIC, SPAIN)*		***ROOM B*** ***Session 7: Ecohydrology in restoration practice - ecosystem management, engineering and society*** ***Conveners:*** *Robert Grabowski (Cranfield University)*
11:00-11:15	**Starving or land of plenty – what dimensionless numbers tell us about material processing in aquatic systems** *[Stefan Peiffer (Department of Hydrology, BayCEER)* ***INVITED****]*	11:00-11:15	**Rivers and restoration practise in Portugal: a brief journey through past, present and the future** *[Samantha Jane Hughes (University of Trás-os-Montes e Alto Douro - Centre for Research & Technology in Agro-Environment & Biological Sciences)* ***INVITED****]*
11:15-11:30	**Identifying hydroclimatological controls on storm-event variability in catchment nutrient dynamics and source zone activation through the use of high-frequency in-situ sensors** *[Phillip Blaen (University of Birmingham)]*	11:15-11:30	**Assessing the transferability of river temperature models between catchments: consequences for river management?** *[Faye Jackson (University of Birmingham)]*
11:30-11:45	**Exploring the Ecohydrological Relationships Between Sand-fixing Vegetation, Soil Moisture and Dune Stability in Kerqin Sandy Land, North China---- a Meta Analysis** *[Wenzhi Zhao (Northwest Institute of Eco-Environment and Resources, Chinese Academy of Sciences)]*	11:30-11:45	**Restoration measures to improve river habitats** *[Judy England (Environment Agency)]*
11:45-12:00	**Small-scale bioturbation has severe impacts on entire ecosystems** *[Joerg Lewandowski (Leibniz-Institute of Freshwater Ecology and Inland Fisheries)]*	11:45-12:00	**Incorporating hydroecology in strategic water resources investigations** *[Stuart Smith (Atkins Ltd)]*
12:00-12:15	**Beaver modifications to catchment hydrology and biogeochemical cycling** *[Joshua Larsen (University of Lausanne)]*	12:00-12:15	**Quantifying long-term macroinvertebrate community responses to groundwater abstraction practices**

12:15-12:30	**Effects of transient hydrologic forcing on Hyporheic Exchange Flow** *[Tanu Singh (University of Birmingham)]*	12:15-12:30	*[James White (Loughborough University)]* **Sustainable Lahar Disaster Risk Mitigation through Community-based Hydrology-Hydraulics Monitoring and Warning System** *[Djoko Legono (Universitas Gadjah Mada, INDONESIA)]*
12:30-13:30	**Lunch Break**		
	ROOM A ***Session 1: Non-linear dynamics (thresholds and tipping points) of ecosystem responses, resilience and adaptation*** ***Conveners:*** *Susana Bernal (CEAB-CSIC, SPAIN)*		***ROOM B*** ***Session 7: Ecohydrology in restoration practice - ecosystem management, engineering and society*** ***Conveners:*** *Bob Grabowski (Cranfield University)*
13:30-13:45	**Algal Stable States in Natural Chemostats: Eutrophication or Mediated Trophic Cascade?** *[Matthew Cohen (University of Florid), **INVITED**]*	13:30-13:45	**Restoration practices and process in France** *[Yves Souchon (IRSTEA) **INVITED**]*
13:45-14:00	**Baseflow recession characteristics of a tropical river in India** *[Lakshman Nandagiri, (National Institute of Technology Karnataka, Surathkal, Mangaluru, India)]*	13:45-14:00	**The importance of being uncertain (when communicating groundwater model predictions)** *[Kate Holland (CSIRO)]*
14:00-14:15	**The recovery and recolonization of aquatic invertebrate taxa in temporary streams following a supra-seasonal drought** *[Paul Wood (Loughborough University)]*	14:00-14:15	**Will Dam Removal Increase Nitrogen Flux to Estuaries?** *[Arthur Gold (University of Rhode Island)]*
14:15-14:30	**Impacts of groundwater pumping on phreatophytes in water-limited regions: Field experiments and numerical simulations** *[Lihe Yin (China Geological Survey)]*	14:15-14:30	**Impact of reservoirs on global carbon cycle changes through development of advanced eco-hydrologic and biogeochemical coupling model** *[Tadanobu Nakayam (National Institute for Environmental Studies)]*
14:30-14:45	**TBC** *[Feng Mao (University of Birmingham)]*	14:30-14:45	**Stream restoration enhances hyporheic fine particle exchange** *[Jennifer Drummond, (Centre for Advanced Studies of Blanes (CEAB-CSIC))]*
14:45-15:00	**Parameters Uncertaining in conceptual hydrological models in a climate change context** *[Cynthia Andraos (Sant Joseph University)]*	14:45-15:00	**Testing Hydrological Suitability for Mangrove Restoration** *[Anne Van Loon (University of Birmingham)]*
15:00-15:30	**Coffee break**		
	ROOM A ***Session 5: Linking hydroecology and ecohydraulics: towards a better understanding of interactions between ecosystems, hydraulics and hydrological processes*** ***Conveners:*** *Valérie Ouellet (Stroud Water Research Center), Stephen Dugdale (University of Birmingham)*		***ROOM B*** ***Session 6: Novel approaches in plant, soil, water atmosphere interactions*** ***Conveners:*** *Josie Geris (University of Aberdeen)*
15:30-15:45	**Conservation of native fish community: merging Ecohydraulics and Ecohydrology in the context of the Jucar River Basin District** *[Francisco Martinez-Capel (Universitat Politecnica de Valencia, Spain) **INVITED**]*	15:30-15:45	**Improved monitoring strategies for understanding greenhouse gas emissions from variable saturated landscapes** *[Trenton Franz (University of Nebraska-Lincoln) **INVITED**]*
15:45-16:00	**Geomorphological variables to predict spatial distribution of plant species in agricultural ditches** *[Gabrielle RUDI (SupAgro / INRA –*	15:45-16:00	**Soil-plant-water interactions at the Sunjia Red Soil Critical Zone Observatory: implications for water and nutrient dynamics**

	FRANCE)]		*[Josie Geris (School of Geosciences, University of Aberdeen)]*
16:00-16:15	**The Ecohydraulics of Dam Renewal** *[Katy Haralampides (University of New Brunswick)]*	16:00-16:15	**Ecohydrological response of apple trees in the Eastern Italian Alps: Water isotopic composition of xylem sap, soil water and groundwater due to rainfall and irrigation events** *[Jay Frentress (Free Univerity of Bolzano)]*
16:15-16:30	**Quantifying the effects of compensation flow releases from impoundments on riverine ecosystems** *[Henk Krajenbrink (Loughborough University)]*	16:15-16:30	**The effect of artificial changes on the intensive macrophyte growth in the river channel** *[Takashi Asaeda (Saitama University)]*
16:30-16:45	**Assessment of potential drought refuges in the Upper Ovens River (Australia), based on UAV Thermal Imagery** *[Roser Casas-Mulet (The University of Melbourne / Water Research Institute, Cardiff University)]*	16:30-16:45	**Assessing efficiency and impediments of root water uptake using thermodynamics** *[Anke Hildebrandt (University of Jena) **INVITED**]*
16:45-17:00	**Novel observations in hydrology: image analysis for streamflow measurements** *[Flavia Tauro (University of Tuscia) **INVITED**]*	16:45-17:00	**Water level and vegetation controls on streambed temperature dynamics** *[Silvia Folegot (University of Birmingham)]*
17:00 – 18:30	***POSTER AREA*** **Poster/ drink reception**		

Friday 23 June 2017

08:00 – 16:00	***BIFOR VISIT of the Birmingham Institute for Forest Research (optional)***

Poster presentations

Rebecca Adams University of Birmingham	*Abundance, characterisation and potential impact of microplastic debris in a UK canal system*
Tanveer Adyel The University of Western Australia	*Stormwater nutrient dynamics during riparian zone saturation and lentic-lotic transition*
Sina Alaghmand	*Groundwater pumping as a salinity mitigation measure to control salt discharge: a case study in a semi-arid small ephemeral catchment in Australia*
Adedolapo Ayoade University of Ibadan	*PHYTOPLANKTON ASSEMBLAGE AND PHYSICOCHEMICAL PARAMETERS OF A PERTURBED TROPICAL MANMADE LAKE, SOUTHWESTERN NIGERIA*
Susana Bernal CEAB-CSIC, Spain	*Human-induced diel cycles in stream functioning in Mediterranean WWTP-influenced streams*
Aimee Brett Lancaster University	*Investigating how plant functional traits can increase the efficiency and capacity of vegetated buffer zones.*
Andre' Brunier University of Strathclyde	*Anticancer drugs as water environment contaminants: data needs for quantitative risk assessment.*
José Manuel Carita Gonçalves National Institute of Biology, Slovenia	*Surveillance of pathogenic enteric viruses at freshwater/seawater interfaces as complementary indicators of water quality*
Roser Casas-Mulet The University of Melbourne / Water Research Institute, Cardiff University	*Assessment of potential drought refuges in the Upper Ovens River (Australia), based on UAV Thermal Imagery*
Natalie Ceperley University of Lausanne, Switzerland	*Current and future partition of evaporation and transpiration in Alpine Environments*
Hichem Chenaker University of Khenchela, Algeria	*Geothermal field studies using stable isotope hydrology: case studies in Algeria*
Sophie Comer-Warner University of Birmingham	*Novel high resolution nitrate isotope method for determination of nutrient fate in aquatic systems*
Danny Croghan	*Applications of high resolution rainfall radar data to*

University of Birmingham	*quantify water temperature dynamics in urban catchments*
Simon Dixon University of Birmingham	*A conceptual model of riparian forest development and channel processes interactions*
Simon Dixon University of Birmingham	*Wetland interfaces in northern peatlands: ecotones in a changing climate*
Bolaji Edward Ekiti State University	*Environmental Impact of Leachate Pollution on Groundwater Sources in Ikere Metropolis, Ekiti State, Nigeria.*
Adebayo Eludoyin Obafemi Awolowo University	*Landuse and Groundwater Chemistry in an Urban Setlement in Nigeria*
Adebayo Eludoyin Department of Geogaphy, Obafemi Awolowo University, Ile-Ife, Nigeria	*Landuse and Groundwater Quality in part of Southwest Nigeria*
Aryeh Fox Zuckerberg Institute for Water Research, The Blaustein Institutes for Desert Research, Ben-Gurion University of the Negev	*Suspended sediment transport and streambed clogging under losing and gaining flow conditions*
Anna Freeman University of Reading/Centre for Ecology and Hydrology, Wallingford	*Zooplankton influence on phytoplankton biomass and community structure in rivers*
Jason Galloway Leibniz-Institute of Freshwater Ecology and Inland Fisheries	*The effect of non-steady overlying water velocity on oxygen and carbon dioxide consumption under losing and gaining conditions*
Alicia García-Arias Universitat Politècnica de Valencia - Research Institute of Water and Environmental Engineering	*Are ecological and hydrological dynamics important in modelling ecohydrological processes?*
Jiaguo Gong Institute of Water Resources and Hydropower Research	*Experimental study on the evolution of sheet flow in rolling waves on a slope surface*

Fang Guohua	*Integrated optimal operation of reservoir based on ecological water demand*
Alexander Hurley University of Birmingham	*Spatio-temporal dynamics of evapotranspiration from forested, ephemeral wetlands and its implication for hydrologic connectivity in the Boreal Plain, Canada*
Anna Jaeger Leibniz-Institute of Freshwater Ecology and Inland Fisheries, Department Ecohydrology, Berlin, Germany	*Using intrinsic diurnal concentration fluctuations in an urban lowland stream to investigate transport and fate of organic micropollutants based on the one-dimensional transport model OTIS*
Iti-Kärt Kiivit Tallinn University	*Widened range of water chemistry compounds and leached humic substances from drained peatlands of Estonian Mustjõgi stream catchment.*
Tamara Kolbe Université de Rennes	*Electron donor distribution controls nitrate removal capacity of an unconfined crystalline aquifer*
Jörg Lewandowski Leibniz-Institute of Freshwater Ecology and Inland Fisheries	*Deuterium and O-18 as tracers for lacustrine groundwater discharge*
HU LIU Northwest Institute of Eco-Environment and Resources, Chinese Academy of Sciences	*Estimate the Irrigation Water Requirement Threshold via Stochastic Model for Maize Cropping in a Desert Oasis of Northwest China*
Zhimin Liu Institute of Applied Ecology, Chinese Academy of Sciences	*Water use sources of typical sand-fixing plants in northeastern China assessed with d2H and d18O*
Jia Liu China Institute of Water Resources and Hydropower Research	*Prediction for the stability of the hydro-ecological system of Qinghai Lake*
Eva Maria Loza Vega University of Birmingham	*Long-term changes in macroinvertebrate communities in streams of Denali National Park, Alaska*
Joerg Lewandowski Leibniz-Institute of	*Small-scale bioturbation has severe impacts on entire ecosystems*

Freshwater Ecology and Inland Fisheries	
Chuanzhe Li China Institute of Water Resources and Hydropower Research	*The Research of Ecological Environmental Water Demand in the Typical Area of the Yellow River Basin, China*
Anna Lupon Swedish University of Agricultural Sciences	*Riparian evapotranspiration regulates stream hydrology but not nitrogen dynamics in a Mediterranean headwater catchment*
Chiara Magliozzi Cranfield University	*Examining the relationships between large wood and hyporheic invertebrates across lowland reaches*
Maria Makaronidou Lancaster University	*Modelling soil temperatures in grassland ground mounted solar photovoltaic parks*
Feng Mao University of Birmingham	*Considering networks in assessment: Integrated evaluation for water management based on ecological networks and the Analytic Network Process*
Amaya Marruedo Leibniz Institute of Freshwater and Inland Fisheries (IGB)	*THERMAL INFRARED IMAGING FOR DETECTION OF UPWELLING FLUXES IN THE WATER SURFACE*
Amaya Marruedo Leibniz Institute of Freshwater and Inland Fisheries (IGB)	*SCALING OF WATER AND HEAT FLUX/EXCHANGE PROCESSES IN FRESHWATER ENVIRONMENTS BASED ON TEMPERATURE TRACERS*
Kei Nukazawa University of Miyazaki	*Catchment-scaled species diversity modeling of stream invertebrates using a hydrological simulation*
Ignacio Peralta-Maraver University of Roehampton	*Hierarchical interplay of hydrology, community ecology and ecosystem services in the hyporheic zone*
Andrea Popp Eawag / ETH Zurich	*Estimating riverbank residence times and oxygen turnover using (noble) gas tracers*
Muhammad Raza IWW Water Centre	*Sorption of carbamazepine, diclofenac, ibuprofen, metoprolol and sulfamethoxazole to sediment from river Erpe, Berlin*
Katie Reilly University of Birmingham	*The effect of colour on microplastic ingestion in Daphnia magna*
Jonas L. Schaper Leibniz-Institute of Freshwater Ecology and Inland Fisheries,	*Seasonal effects on hyporheic and whole stream attenuation of polar organic trace compounds in an urban stream in South Australia*

Department	
S.K. Sharma Carman Residential and Day School	*Interface of fluorite with shallow water aquifers in parts of India, its health implications and remediation techniques*
Suffeiya Supian University of Birmingham	*Uptake of differently sized microplastics in gut passage by different species of Daphnia*
Valentin Tembe Mwala Official journal of Democratic Republic of congo	*Ensuring a better future for water in the Democratic Republic of Congo case ; kasai river*
Ping Wang Institute of Geographic Sciences and Natural Resources Research, CAS	*Integrating root dynamics into Noah-MP for modeling desert phreatophytes*
Xin Wen Hohai University	*Adapting the operation of cascaded reservoirs on Yuan River for fish habitat conservation*
Ashvin Wickramasooriya Department of Geography, University of Peradeniya, Sri Lanka	*Effect of water level fluctuation at Victoria reservoir, Sri Lanka on water level of wells located closer to the reservoir*
Liwen Wu Leibniz-Institut für Gewässerökologie und Binnenfischerei	*Impacts of Flood Pulses on Hyporheic Zones*
Huang Xianfeng Hohai University	*Risk-Benefit Quantification of Floodwater Resources Utilization*
Yuntao Ye China Institute of Water Resources and Hydropower Research	*Influence of the operation of the Three Gorges Project on wintering waterbird habitats on the East Dongting Lake, China*
Jay Zarnetske Michigan State University	*Hydrologic residence time controls the fate of carbon and nitrogen at a lake-groundwater interface*
Zhengli Zhai	*The Analysis and Calculation of Target Blue Water Consumption for Sustainable Water Resource*
Minghui Zhang University of California, Berkeley	*Streamflow Prediction in Ungauged, Irrigated Basins*
Haitao Zhang N/A	*China system of environmental and economic accounting for water*

Shuanghu Zhang China Institute of Water Resources and Hydropower Research	*Analysis of Long-Term Water Level Variation in Dongting Lake, China*

Abstracts

Keynote Speakers

Michael McClain:

Application of Ecohydrology to achieving the 2015-2030 Sustainable Development Goals

Michael McClain
INESCO IHE

In September 2015, the 193 countries of the United Nations agreed to the 2030 Agenda for Sustainable Development, which is composed of 17 Sustainable Development Goals (SDGs) and 169 targets. The fundamental aims of the agenda are to end poverty and hunger, combat inequalities within and among countries, build peaceful, just and inclusive societies, protect human rights and ensure the lasting protection of the planet and its natural resources. Among the global calls for action are the mobilisation of scientific, technological, and innovative capacities to address key problems and assess the earth system processes underpinning sustainability. Ecohydrology is relevant to several SDGs and essential to Goal 6: "Ensure availability and sustainable management of water and sanitation for all", and especially its targets 6.3 focusing on water quality improvement, 6.4 focused on improving water use efficiency, and 6.6 focused on protecting and restoring water-related ecosystems. Together, pursuit of these targets enables wise water resource management in support of other goals related to more healthy lives and sustainable economic development.

Much of our work in ecohydrology to date has focused on understanding the ecology-hydrology-human interactions influencing changing aquatic and terrestrial environments. To have a meaningful impact on the global sustainable development agenda, however, we must increase our engagement in the application of ecohydrology under Agenda 2030. In relation to target 6.3, for example, this involves increased effort to analyse ecohydrological process regulating water quality and properly embed new knowledge in both natural and engineered green infrastructure (nature based solutions). For target 6.4 additional effort is needed to understand the levels of stress imposed on ecosystems and related loss of services (including water quality regulation) due to withdrawals for off-stream uses. And for target 6.6 renewed effort is needed to measure changes in the extent and health of water-related ecosystems and understand the manageable factors that can to improve protection and restoration.

To achieve impact ecohydrologist must also become more active and visible in UN initiatives such as GEMI, established in 2014 as a UN inter-agency initiative to develop a coherent monitoring framework, with improved data collection and analysis, focused on Goal 6 targets. Strengthened partnerships are also needed

between the ecohydrological research community and resource management agencies at home and abroad, especially in the context of development initiatives in Africa, Asia, and Latin America.

Steven Gorelick:

The role of agent-based models in faunal ecohydrologic analysis

Steven M. Gorelick Ellen M. Ward Hua Zhang
Stanford University

Ecohydrology has largely focused on plant-water interactions with coupled animal-water systems accounting for less than 20 percent of prior studies, such as those relating beaver dams or fish populations to streamflow, or connecting alligators to aquatic refugia. A promising avenue of research in the field of faunal ecohydrology involves developing a comprehensive understanding of population variability tied to habitat quality, which itself is a strong function of hydrologic response. We present two examples of spatially explicit agent-based models that track responses of individuals to changes in habitat, the quantity and quality of which are significantly affected by flooding. In one case, we demonstrate a predictive multi-process framework to explore spatially explicit shorebird population changes as a function of wetland habitat suitability and future sea-level rise. In the second case, we present a preliminary conceptual model of spatial and temporal changes in a semi-aquatic mammal population, which is controlled by the filling and drying of hundreds of shallow floodplain lakes and their provision of essential habitat. In both cases, the coupled habitat-hydrologic-animal population model can provide insights into the dynamic effects of habitat quality on population, and the model can serve as a useful tool to quantify how animal population decline is related to critical habitat destruction.

Chris Soulsby:

Multi-scale connectivity of landscapes and riverscapes as a control on the ecohydrology of Atlantic salmon nursery streams

Christopher Soulsby
Aberdeen University

Aquatic organisms experience a physico-chemical environment in the riverscape that is strongly influenced by hydrological and biogeochemical processes in the catchment landscape. Atlantic salmon are a species that have a complex life-cycle with markedly differing life stages that utilize contrasting features of in-stream habitats. They therefore provide instructive insights in to the ecohydrological importance of the spatial and temporal dynamics of landscape and riverscape connectivity. In this contribution we focus on the Girnock burn, a long-term (>50 years) monitoring site for Atlantic salmon populations in the Scottish highlands. The influence of landscape hydrology on in-stream hydraulics and water quality is shown to be a key control on various life stages of Atlantic salmon (e.g. spawning, fry emergence, juvenile growth and out-migration). In addition to general seasonal patterns, extreme high and low flow events and the ecological response are also assessed. The importance of integrated, inter-disciplinary studies at long-term sites will be shown to be of critical importance to understanding the likely effects of future environmental change.

Angela Gurnell:

Plants as physical engineers of river ecosystems

Angela Gurnell
School of Geography Queen Mary University of London

Traditionally, the form and dynamics of river systems and their floodplains have been attributed largely to interactions between river flows and sediment. These interactions drive the erosion, transport and deposition of sediment and thus the construction and removal of hydrological, hydraulic and sediment habitats. Vegetation colonises some of these habitats, but this has been viewed as a passive process, occurring only where the physical processes are weakest and 'allow' vegetation colonisation. However, recently and particularly over the last 20 years, the crucial role of some plant species in initiating and stabilising 'pioneer' river landforms and habitats has been increasingly recognised. Following initiation, these pioneer landforms can aggrade and coalesce, driving local habitat construction and

turnover, and at larger space and time scales, river and floodplain morphological adjustment. This presentation will focus upon the way in which certain aquatic and riparian plant species act as river 'engineers' within certain flow and sediment process settings. Physical processes ultimately constrain the hydrological and hydraulic environment of rivers and their margins, and thus the plant species that are capable of survival within that physical environment. In turn, some of these species interact strongly with the physical processes, influencing the types of pioneer landforms that may evolve, stabilising the landforms, and so facilitating colonisation by other plant species. The effects of these plant-physical process interactions on river morphodynamics are recognisable from plant to reach scales. These multi-scale effects will be illustrated within a range of environmental settings from warm and seasonally dry to cool and continuously wet.

Hjalmar Laudon:

Understanding the fifty shades of brown: The need to combine long-term monitoring with process-based research across spatial and temporal scales

Hjalmar Laudon
Department of Forest Ecology and Management, Swedish University of Agricultural Sciences, Umeå, Sweden

Most research on the mechanisms that regulate the color of streams – or the concentration of dissolved organic carbon (DOC) - is based either on individual well-studied catchments, or geographically distributed monitoring datasets. While studies based in research catchments often is fruitful because of the large amount of ancillary information that can provide mechanistic explanations, the results are often difficult to extrapolate because of limited statistical and geographic representation. Conversely, environmental monitoring sites often lack the process-based designed data collection, which instead makes it difficult to infer causal relationships. Here I will discuss the value of combining long-term monitoring time-series with the exclusivity of process-based research across multiple spatial and temporal scales. The basis for this presentation will be on the Krycklan Catchment Study (www.slu.se/Krycklan) located in northern Sweden that provides a unique field experimental platform for hillslope to landscape-scale research on long-term ecosystem dynamics in the boreal landscape. The site is designed for processes-based research needed to assess the role of external drivers such as forest management, climate change, and long-range transport of pollutants on forests, mires, soils, streams, lakes and groundwater. In my presentation I will discuss some examples of how Krycklan has developed into a state-of-the-art field infrastructure for experimental and hypothesis driven research, maintained the long-term climatic,

biogeochemical, hydrological and environmental data collection of highest quality, and how this has supported the development of new models and guidelines for research, policy and management.

Laurel Larsen:

Data-driven research in a nonstationary world: a top-down approach to understanding critical interactions and scales from the catchment to the planet

Laurel Larsen (1) Saalem Adera (1) Dino Bellugi (1) Judson Harvey (2) Hong-xu Ma (1) Christopher Tennant (1)
University of California, Berkeley

One consequence of earth systems moving out of a regime of stationarity is that statistical models may no longer be useful for predicting future behavior. Rather, an understanding of the mechanisms driving dynamic earth systems is needed. The mechanisms responsible for nonlinear—even surprising—behavior often involve feedbacks between biotic and abiotic processes. Examples of these feedback processes abound in aquatic sciences, where flow, vegetation, sediment, topographic, and biogeochemical processes tend to exhibit strong coupling. Effects of biotic-abiotic feedback processes may be examined using numerical models (a bottom-up approach), but because multiple feedback processes may produce the same outcome, these studies may not be conclusive. How, then, is the aquatic scientist to determine the processes responsible for particular phenomena at particular places, in a timely manner such that useful predictions can be generated? Although correlative field studies may be useful for generating hypotheses about system drivers, they are often not sufficient to resolve causally important processes in complex hydrologic systems with multiple limiting factors or nonlinearities. An emerging alternative to the bottom-up method is a top-down approach in which causal interactions and their critical spatiotemporal scales are delineated directly from data using emerging frameworks of inference. Challenges of not knowing the functional form of the relationship between drivers or which of several potential drivers is limiting a response at any time are dealt with by performing analyses in the framework of uncertainty reduction rather than prediction. If a variable (such as discharge) uniquely and independently reduces the uncertainty of another variable (such as ecosystem respiration) over particular time lags, we conclude that it exerts a causal influence. In this manner, and using a stream gaging station data record, we show that fine sediment deposition by intermediate-size storms boosts stream metabolism over timescales of 100+ days in an urban stream that is limited by particulate carbon. Conversely, large storms depress stream respiration over timescales of one month in streams with close coupling between gross primary productivity and respiration but over 1-2 day timescales in streams where these

processes remain uncoupled. Application of these methods over larger spatial scales can reveal critical spatial scales and pathways of rainfall recycling in transitional forests of Brazil, or the most prominent drivers of global temperature changes during historic transitions from glaciated to unglaciated states. These case studies highlight the potential for application of these emerging causal inference techniques to the vast library of hydroecological data already collected, provide insight into optimal strategies for data collection in new sensor networks, and showcase how data-driven research may improve mechanistic model generation, as in the prediction of streamflow responses to precipitation.

Meritt Turetsky:

The effects of thermokarst on landscape change and permafrost carbon release in northern ecosystems

Merritt R. Turetsky
University of Guelph

Carbon release from permafrost thaw and the microbial decomposition of previously frozen organic matter is considered one of the most likely positive feedbacks from terrestrial ecosystems to the climate system in a warmer world. Permafrost thaw can involve the gradual deepening of the seasonally thawed layer, but in certain landscape types also can occur via abrupt thermokarst development that potentially affects the entire soil profile. While the formation of thermokarst and subsequent recovery of permafrost is part of the natural succession of many northern ecosystems, rates of thermokarst increase with warming, human disturbance, or wildfire. Thermokarst exposes previously-frozen carbon to microbial processes but also alters hydrology. Critical for predicting carbon balance is understanding whether permafrost carbon, upon thaw, will be exposed to aerobic or anaerobic conditions. Changes in hydrology may cause permafrost carbon to be incorporated into a saturated zone, either as a result of subsidence or down-slope transport, where it may experience anaerobiosis. If saturated, overall rates of carbon mineralization and loss will be slower but permafrost carbon is more likely to released to the atmosphere in the form of methane, which has a stronger radiative forcing than carbon dioxide. We are using mapping activities, data synthesis and simple land cover change modeling to better understand the relevance of thermokarst to the overall permafrost carbon feedback. We estimate that thermokarst terrains cover 3.6 x 106 km2, or 20% of the northern permafrost domain. However, given disproportionally high soil organic carbon content, thermokarst terrains are estimated to store ~30% of the total permafrost domain soil organic carbon stored in the upper 3 meters of soil, and likely an even larger fraction when deeper carbon stocks are considered. On a century timescale,

cumulative carbon losses from thermokarst are of similar magnitude to estimates of permafrost carbon losses associated with widespread top-down thaw.

Steven Loheide:

The influence of groundwater on agroecosystems and vice versa

Steven Loheide (1) Sam Zipper (1) Esteban Jobbagy (2) Raul Gimenez (2)
University of Wisconsin

Two case studies will be used to demonstrate the influence that agriculture exerts on groundwater systems and conversely, the effect that shallow groundwater can have on agroecosystems. First, we will demonstrate that conversion of natural lands to rainfed agriculture alters plant water use, changing the timing and magnitude of groundwater recharge. Shallow root systems and shorter growing seasons for crops leads to increased groundwater recharge. We observe and model this effect in the Argentinian Chaco, where rising groundwater levels threaten the sustainability of agriculture in the region. However, lateral groundwater transfers to remnant patches of native dry forest temper this response and suggest feasible management strategies for the region. Second, we demonstrate the effect of shallow groundwater on yield in corn fields in Wisconsin, US. Very shallow groundwater decreases yield due to oxygen stress within the root zone, whereas deep groundwater has no effect on crop yield. At intermediate depths, crop yield is maximized by a groundwater subsidy provided when groundwater is within or near the root zone. The two-way interactions between agroecosystems and groundwater regimes suggests the need for evaluating the two jointly to enhance productivity and sustainability of agricultural regions world-wide.

Nancy Grimm:

TBC

Arizona State University

Glenn Watts:

TBC

Environment Agency, Kings College London

Jeffrey McDonell:

Compartmentalization of the terrestrial water cycle

University of Saskatchewan

The catchment water balance is the most important equation in ecohydrology. But the smooth rhythm of the terrestrial water cycle turns out to be more compartmentalized than previously thought. New dual isotope work with 18O/16O and 2H/1H shows that plants transpire water from soil water pools that do not mix with more mobile water that recharges groundwater and streamflow. An observation that began as an oddity at a single field site now has gained support from dual isotope datasets across diverse biomes as well as from global satellite 2H/1H vapor measurements. This ecohydrological compartmentalization can lead to transpired soil water several decades old with portions perhaps of older water still. Meanwhile, the subsurface too appears compartmentalized where recent 14C work has shown that groundwater below 250 m is mostly pre-Holocene age despite a sizeable fraction of global streamflow that is less than a few months old. I describe some of this work and its impacts on how we understand and model streamflow, groundwater, plant transpiration and their ecohydrological interactions.

Keith Smettem:

New potentiometric chloride sensors provide high resolution information on physical transport and exchange processes in streams

Keith Smettem[1,2], Julian Klaus[3], Nick Harris[4] and Laurent Pfister[3]
Murdoch University and University of Western Australia

Quantifying the travel times, pathways and dispersion of solutes moving through stream environments is critical for understanding the biogeochemical cycling processes that control ecosystem functioning. Validation of stream solute transport and exchange process models requires data obtained from in-stream measurement of chemical concentration changes through time. This can be expensive and time consuming, leading to a need for cheap distributed sensor arrays that respond instantly and record chemical transport at points of interest on timescales of seconds. To meet this need we introduce a new low-cost potentiometric chloride sensor that can be used in a distributed array to obtain data with high spatial and temporal resolution. The application here is to monitoring in-stream hydrodynamic transport and dispersive mixing of an injected

chemical, in this case NaCl. We present data obtained from the distributed sensor array under baseflow conditions for stream reaches in Luxembourg and Western Australia. The reaches were selected to provide a range of increasingly complex in-channel flow patterns. Sensor results are comparable to data obtained from more expensive electrical conductivity meters but allow far greater spatial resolution of hydrodynamic mixing processes and identification of chemical ‘dead zones’ in the study reaches.

Oral presentations
S1. Threshold and Tipping Points: Non-linear dynamics (thresholds and tipping points) of ecosystem responses, resilience and adaptation

Conveners: Susana Bernal

Starving or land of plenty – what dimensionless numbers tell us about material processing in aquatic systems

Carolyn Oldham Sven Frei Ben Gilfedder

Department of Hydrology, BayCEER
Presenter: Stefan Peiffer
Type of Presentation: ORAL

Abstract

Biogeochemistry is dealing with those chemical reactions that are thermodynamically possible, but kinetically inhibited. Life has found solutions to make use of the free energy available and to establish ecological niches, particularly at environmental interfaces with strong gradients in chemical properties (redox, pH, concentration). A requirement to maintain biogeochemical activity is the supply of substrate or removal of products which is ultimately linked to transport. As an example, Beer & Blodau (2007) have demonstrated that constraints on the removal of products from acetoclastic methanogenesis in deeper peat layers are inhibiting organic matter decomposition and provide a thermodynamic argument for peat accumulation. In other words, material processing in these systems is transport limited. The key to understand such controls is the balance between two time scales (Oldham et al, 2013): the time required to process substrate (or accumulate products) which is the reaction time scale, and the time at which the system is exposed to favourable conditions. It was suggested to discuss efficiency of material processing in terms of the dimensionless number NE, which relates the exposure time-scale to the reaction time-scale. Hence, NE values >> 1 predict highly efficient material processing in an aqueous system and vice versa. It was hypothesized that, from an ecological point of view, those systems are resilient that have evolved under conditions of NE ~ 1, i.e. conditions where both time scales on average balance each other (Oldham et al, 2013). Both of these time scales are not trivial to determine. Particularly, the exposure time depends on hydrological processes such as stream-runoff variation and on scale, changing from a diffusive length scale to an advective length scale. In this presentation, the application of the NE number to assess scale dependent denitrification efficiency in a river reach will be discussed. Beer, J; Blodau, C (2007): Transport and thermodynamics constrain belowground carbon turnover in a northern peatland, Geochim. Cosmochim. Acta, 71, 2989-3002 Pittroff, M; Frei, S; Gilfedder, B (2016): Quantifying nitrate and oxygen reduction rates in the hyporheic zone using 222Rn to upscale biogeochemical turnover in rivers, Water Resources Research, DOI 10.1002/2016WR018917 Oldham, C; Farrow, DE; Peiffer, S (2013): A generalized Damköhler number for classifying material processing in hydrological systems, Hydrology and Earth System Sciences, 17, 1133-1148

Identifying hydroclimatological controls on storm-event variability in catchment nutrient dynamics and source zone activation through the use of high-frequency in-situ sensors

Phillip Blaen (1,2), Kieran Khamis (1), Charlotte Lloyd (3), Stefan Krause (1,2)

University of Birmingham
Presenter: Dr Phillip Blaen
Type of Presentation: ORAL

Abstract
At the river catchment scale storm events can drive highly variable behaviour in nutrient and water fluxes, yet short-term dynamics are frequently missed by low resolution sampling regimes. In addition, nutrient source contributions can vary significantly within and between storm events. Our inability to identify and characterise time dynamic source zone contributions severely hampers the adequate design of land use management practices in order to control nutrient exports from agricultural landscapes. Here, we utilise an 8-month high-frequency (hourly) time series of streamflow, nitrate concentration (NO3) and fluorescent dissolved organic matter concentration (FDOM) derived from optical in-situ sensors located in a headwater agricultural catchment. We characterised variability in flow and nutrient dynamics across 29 storm events. Storm events represented 31% of the time series and contributed disproportionately to nutrient loads (43% of NO3-N and 36% of CDOM) relative to their duration. We examine hydroclimatological controls on catchment nutrient dynamics to develop predictive models of inter-event variability in water quality and catchment nutrient export. Hysteresis analysis of nutrient concentration-discharge relationships suggested spatially discrete source zones existed for NO3 and FDOM, and that activation of these zones varied on an event-specific basis. Our results highlight the benefits of high-frequency in-situ monitoring for characterisation of complex short-term, nutrient dynamics and unravelling connections between hydroclimatological variability and river nutrient export and source zone activation under extreme flow conditions. These new process-based insights are fundamental to underpinning the development of targeted management measures to reduce nutrient loading of surface waters.

Exploring the Ecohydrological Relationships Between Sand-fixing Vegetation, Soil Moisture and Dune Stability in Kerqin Sandy Land, North China---- a Meta Analysis

Wenzhi Zhao* Hu Liu

Northwest Institute of Eco-Environment and Resources, Chinese Academy of Sciences
Presenter: Prof Wenzhi Zhao
Type of Presentation: ORAL

Abstract
Bi-modality was frequently observed in nature ecosystem especially where resources limited. For example, dryland plant systems are tend to exhibit bi-stable dynamics with two preferential configurations of bare and vegetated soils (D'Odorico, 2005), and two preferential states may also arise in summer soil moisture dynamics, which tend to remain locked either in a 'dry' or a 'wet' state. (D'Odorico, 2004). Sand-fixing vegetation under no-irrigation condition was firstly established during 1960s in northern China, which is a successful model of protective system for desert oasis in arid China. An unique self-organized pattern of sand dunes had been observed in the vegetation colonized regions 10 to 20 years later since then. However, few reports could be found so far for the stability evolution of the dune systems during the past decades, and the ecohydrological relationships between vegetation and moisture at different stages of the evolution. We intensively collected literature data from reports (published mainly during 2000 through 2015) evaluating soil and water resources in Kerqin sandy land of north China, including soil moisture, vegetation conditions (i.e. vegetation ages, coverage, growth), soil profile features, climate elements and so on. The stability of the dune systems was evaluated via a modified Lancaster's sand mobility index (M=W/P:PE). The data of a pioneer plant species (Caragana sinica, which was widely used for sand-fixing in arid north China), are specially selected in this study to explore the relationships between sand-fixing vegetation, water resources and dune stability in this region. The cusp catastrophe model is employed in the mete analysis to detect the potential role of eco-hydrological feedbacks in between soil and vegetation, because it is capable of handling complex relationships simultaneously using a high order probability density function that has the advantage of being able to incorporate sudden behavioral jumps (Zeeman, 1976). We found that the relationship between vegetation and water during the evolution of sand dune systems can be clearly represented by the long-term average of soil moisture. Our estimation also suggested that sand dunes colonized by Caragana sinica have a catastrophic disruption threshold (s=3.76, v = 48.7%) in its stability, and there exist a possibility space (27a-4ß3>0, s<12%, v<100%) wherein the stability of dune systems may be suddenly disrupted. However, the chance of occurrence of catastrophic disruption in Kerqin sandy land is rare and its significance is unnoticed under the current climate conditions according to our analysis. In general, the more precipitation and better soil moisture conditions, the better chance such a dune system gets or loss its stability during short period or in a sudden burst of development.

Small-scale bioturbation has severe impacts on entire ecosystems

Jörg Lewandowski, Franz Hölker, Viktor Baranov, Michael Hupfer

Leibniz-Institute of Freshwater Ecology and Inland Fisheries
Presenter: Joerg Lewandowski

Type of Presentation: ORAL

Abstract
Tube-dwelling organisms such as chironomids pump large water volumes through their burrows in the sediment. For shallow lakes we could show that volumes equivalent to the whole water body can be pumped through the tubes on time scales of days to weeks. Filter rates of the chironomids are in the same order of magnitude as those of zooplankton. Intermittent pumping by macrozoobenthos introduces oxygen into anoxic sediment layers and creates a dynamic, three-dimensional mosaic of different redox conditions and zonations. Bioturbation is a major driver of aquatic sediment respiration. Hotspots of element cycling occur at the oxic-anoxic interfaces controlling the fate of organic matter and nutrients in shallow aquatic ecosystems as well as fluxes of nutrients (N, P) between sediment and overlying water. Chironomids modify P burial, the stoichiometry of nutrients in the water body and thus alter the trophic state of lakes. Therefore, we postulate that chironomids are small but abundant 'ecosystem engineers' exerting high filter-feeding pressure and affecting biogeochemical processes from the micro scale to the ecosystem scale, especially in shallow lakes ecosystems. Figure taken from Hölker et al. (2015, Ecological Monographs, 85(3), 333–351): Mechanisms by which tube-dwelling invertebrates may control water quality and trophic status (Chironomus plumosus larvae used as an example for tube-dwelling invertebrates).

Beaver modifications to catchment hydrology and biogeochemical cycling
Joshua Larsen (1,2), Annegret Larsen (1), Stuart Lane (1)

University of Lausanne
Presenter: Joshua Larsen
Type of Presentation: ORAL

Abstract
The ability of beavers (castor fiber, castor canadensis) to engineer ecosystems is well recognised. However, quantification of the feedbacks and implications of this engineering for hydrological and biogeochemical processes remains challenging. Following widespread population reductions, many ecosystems are now transitioning as beaver populations are reintroduced, highlighting the importance of better understanding the process feedbacks. The construction of in-channel dams from woody debris by Beaver populations within low order stream networks can convert comparatively fast flowing streams with short water residence times to a series of dams, ponds, and floodplain wetlands and meadows which typically have much longer residence times. Here, we review the current state of knowledge on the hydrological and biogeochemical feedbacks associated with beaver impacted river systems, and also provide examples from recent monitoring campaigns in Switzerland. In particular, the mechanisms controlling the extent of beaver impacts on the partitioning of the water balance, flow regime, and nutrient (carbon, nitrogen, phosphorous) cycling are examined. These potentially profound impacts

have important implications for the water, nutrient, and pollution management of low order river systems.

Effects of transient hydrologic forcing on Hyporheic Exchange Flow

Liwen Wu Anders Wörman David M.Hannah Stefan Krause Jesus D. Gomez-Velez

University of Birmingham
Presenter: Tanu Singh
Type of Presentation: ORAL

Abstract
Stream stage fluctuations and streambed topography induce pressure gradients along the sediment-water interface and drive hyporheic exchange flow (HEF). Previous studies have paid little attention on the potential impacts of time-dependent hydrologic forcing such as flood pulses. The impact of floods on the HZ is not only confined to physical disturbance of sediments but also affects the availability of solutes and eventually biogeochemistry of the streams, which makes it significant for water quality and aquatic life. A numerical subsurface model was constructed combining flow, solute transport and residence time models with a temporally changing upper boundary conditions to explore the HZ behaviours in response to dynamic hydrologic forcing. Different values of aspect ratios, slopes, flood intensities and skewness, and bankful discharge were used for sensitivity analysis to elucidate the effects of a flood pulse on expansion and contraction of HZ, residence time of water in the HZ and likely locations of oxic/anoxic zones for different timescales of oxygen consumption. The results showed that the relative change in hyporheic flux increases for higher flood intensities, although ambient flow driven by the channel gradient in the streambed constrained the significant changes in pressure distributions. Moreover, we found that flood pulse significantly affects residence time and solute transport in streambed. Consideration of multiple morphological characteristics along with hydrological controls facilitates upscaling in river network scale.

Algal Stable States in Natural Chemostats: Eutrophication or Mediated Trophic Cascade?

Robert T. Hensley Dina M. Liebowitz James B. Heffernan Rachel L. Nifong Thomas K. Frazer

University of Florida
Presentor: Matthew Cohen
Type of Presentation: ORAL

Abstract
Algal growth in freshwater ecosystems is frequently viewed through the singular lens of nutrient enrichment, often at the expense of systems-level explanations. In Florida's spring fed rivers, the eutrophication narrative has dominated management discourse about algal proliferation despite considerable contrary evidence. This talk

synthesizes three research narratives about ecological change in these iconic flowing water ecosystems. First, I present multiple lines of evidence – including system-scale metabolism, inference from tissue stoichiometry, and nutrient depletion assays – that together suggest persistent nutrient saturation of primary production, even under background loading conditions. Second, I summarize evidence strongly supporting trophic interactions as the basis for state transitions, albeit with the caveat that the parameters describing regime shifts between algal and vascular plant stable states vary spatially, thereby creating response heterogeneity. Finally, I present recent evidence linking state transitions towards algal dominance to episodic flow reversals that have increased dramatically in frequency and duration in the last two decades. A coherent narrative emerges linking nuisance algal proliferation to both pulse and press changes in flow and dissolved oxygen, which in turn create a trophic cascade via impacts to aquatic grazer density and vigor. These results point to specific management targets for restoration interventions in Florida's springs, and also highlight more general hydroecological coupling integral to understanding flowing water ecosystems.

BASEFLOW RECESSION CHARACTERISTICS OF A TROPICAL RIVER IN INDIA

Niyanth Kumar K, Lakshman Nandagiri

National Institute of Technology Karnataka, Surathkal, Mangaluru, India
Presenter: Prof Lakshman Nandagiri
Type of Presentation: ORAL

Abstract
The present study was taken up to characterize the phenomenon of baseflow recession in the Netravathi river which flows through the humid tropical region of Karnataka State in south-western India. While runoff in the Netravathi during the monsoon season (June – September) is generated due to heavy rainfall in excess of 3500 mm, dry season (October – May) runoff when rainfall is non-existent, is derived entirely from baseflow contributions. The river is an important source of drinking water supply to Mangaluru City and in recent years, due to increased water demands, ensuring reliable urban water supplies during the dry season is posing a challenge. In addition, there is a feeling that the low flows in the Netravathi river may be exhibiting a downward trend due to increased groundwater withdrawals and land use/land cover changes in the upland parts of the catchment. Therefore, there is a need to characterize baseflow recessions and identify factors influencing interactions between surface water and groundwater during the dry season. Accordingly, historical daily flow records for four gauging sites on the river were used in the present study. Of these, the Bantwal site is located downstream (3400 km2) while the Gundia (154 km2), Gowrihole (125 km2) and Subramanya (186 km2) sites provided flow data for upstream tributaries of the Netravathi river. Daily flow records for historical periods ranging from 13 years to 29 years for the four gauging stations were procured and monotonically decreasing flow series corresponding to only the non-monsoon season were extracted for each year of record. Three published baseflow recession models – one based on a single linear

reservoir, another based on two linear reservoirs and yet another based on a non-linear reservoir were fitted to individual year flow recessions and also to the master recession curves derived for each gauging site. Also, historical monthly water levels in the unconfined aquifer measured in four open wells located close to the river gauging sites were subjected to recession analysis. While the two linear reservoir model proved to be the best descriptor of baseflow recession at all gauging sites, the groundwater recession in all four wells was adequately described by the single linear reservoir model. This implies that the river may be receiving groundwater contributions from both the unconfined and confined aquifer systems. Significant differences in baseflow recession rates between years and between sites were evident. During a given year, the duration of recessions were shorter in the tributaries indicating progressive drying up of the river from upstream reaches to the downstream Bantwal site. The present study is aimed at improving our understanding of the spatio-temporal behaviour of baseflow recessions and factors influencing surface water-groundwater interactions in a humid tropical river basin. Results obtained from the study will prove useful in formulating appropriate management policies aimed at ensuring sustainable levels of flows in such environments.

The recovery and recolonization of aquatic invertebrate taxa in temporary streams following a supra-seasonal drought

Paul Wood, Matthew Hill, Kate Mathers, Sally Little, Thomas Worrall, John Gunn

Loughborough University
Presenter: Dr Paul Wood
Type of Presentation: ORAL

Abstract
The organisms inhabiting temporary streams typically display life history characteristics that enable them to persist during periods with no surface flow and withstand the wetting and drying of instream habitats. In temperate climatic regions, surface flows in temporary streams are largely predictable, with stream flow usually occurring during winter and spring months. However, temporary streams may experience multiple wetting and drying periods on an annual basis reflecting local hydrogeology, site location in the stream network, and short to long-term hydro-climatic patterns. This paper outlines the results of a study examining the recovery and recolonization of aquatic invertebrates in the headwaters of the River Lathkill (Derbyshire, UK) following a supra-seasonal drought. Recolonization of the upper 4 km of the river by aquatic fauna was rapid with the resumption of surface flow and longitudinal connectivity. However, there were marked differences between the ephemeral headwaters (typically dry for >6 months each year) and downstream sites which rarely dry under normal conditions, but were completely dry during the supra-seasonal drought. Recolonization of the ephemeral headwaters was punctuated by variable faunal richness and abundance associated with multiple wetting and drying events. In contrast, faunal richness at downstream sites

increased rapidly at the start of the study period and remained relatively stable thereafter. The results illustrate that temporary stream aquatic invertebrate populations and communities are dynamic and may vary over relatively small spatial scales. There is a need to characterise the biotic and abiotic differences influencing these systems to understand the process of recovery.

Impacts of groundwater pumping on phreatophytes in water-limited regions: Field experiments and numerical simulations

Lihe Yin, Yangxiao Zhou, Dandan Xu

China Geological Survey
Presenter: Dr Lihe Yin
Type of Presentation: ORAL

Abstract
Balancing the water demand between human and ecosystems remains a challenge in water-limited regions. In this study, we examined the short-term and long-term groundwater pumping on phreatophytes. Firstly we tested the hypothesis that short -term groundwater pumping may minimize negative impacts of groundwater withdrawal on phreatophytes. To achieve this, a 23-day pumping in 2014 was performed in a semi -arid site of NW China. The results indicate that sap flow velocity of groundwater-dependent willow trees began to decrease on day 4 after 21 pumping and fully recovered on day 9 after the cessation of pumping. Numerical simulations using HYDRUS-1D were conducted for the period of 1954 -2013 to assess the response of phreatophytes to pumping under various climatic conditions. The modeling results reveal that the detrimental effects of groundwater abstraction can be mitigated by rainfall, particularly high amount and/or high frequent rainfall during/after pumping. Secondly, HYDRUS-1D was used to numerically assess the controls of depth to water table and mean annual precipitation on the impact of water table decline on groundwater-dependent vegetation for sites in the broad NW China (about 3.3 million km2) under long-term pumping. An exponential decay was observed between the normalized transpiration (Tan) and the increasing depth to water table and a positive linear relationship was found between the Tan and mean annual precipitation (MAP). Based on these two relationships, a predictive model was developed to forecast the response of phreatophytes to groundwater drawdown using MAP only and the validation in the other independent 20 sites indicates that the predicted response is comparable to the modelling results. This study provides water resources managers an alternative method to mitigate the conflict of water demand between ecosystems and socio-economic activities in semi-arid zones by a short-term, periodic pumping and provides a predictive model to quantitatively assess long-term groundwater pumping on phreatophyte in order to develop groundwater sustainably in water-limited zones.

Parameters uncertainties in conceptual hydrological models in a climate change context

Cynthia Andraos Wajdi Najem
Saint Joseph University, Beirut, Lebanon

Presenter: Cynthia Andraos

Type of Presentation: Oral

This study aims to quantify the uncertainties in conceptual hydrological models due to parameters estimation in the context of climate change impacts. Two hydrological models are used (GR4J and MEDOR) on 3 Lebanese catchments (Nahr Ibrahim, Nahr El Kalb and Nahr Beirut). The source of errors considered is the uncertainty related to the climatic specificity of the calibration period. To quantify this uncertainty on model outputs, 3 climatically contrasted sub-periods are identified in the observed time series: a wet period, a mean period and a dry period. The models are calibrated on each of these sub-periods and the outputs generated by these three types of calibrations are analyzed in validation on another dry period. The results show that the climatic specificity of the calibration period has a significant impact on the simulation of discharge, especially for low flow rates. Then the uncertainty due to equifinality of parameter sets is taken into account by considering each type of calibration outputs associated with all the acceptable parameter set.

S2. Dynamic process interactions at ecohydrological interfaces across spatial and temporal scales (Special session: INTERFACES)
Conveners: Gilles Pinay, David Hannah, Stefan Krause

From continuous to discontinuous: Spatial stream flow intermittency dominates carbon quantity and quality in a headwater mountain stream

Jay P. Zarnetske, Stephen Plont, Adam S. Ward, Noah Schmadel

Michigan State University
Presenter: Jay Zarnetske
Type of Presentation: ORAL

Abstract
A fundamental objective of watershed biogeochemistry and ecosystem ecology is to determine the biophysical controls of stream dissolved organic carbon (DOC) quantity and quality, because DOC is a master variable in stream ecosystems and water quality. At the core of this objective is identifying the spatial scales (e.g., catchment versus local) that control DOC sourcing and processing in streams. Streams get most of their organic carbon from terrestrial ecosystem productivity (allochthonous sources). The primary pathway that this carbon is moved from terrestrial origins to the stream is via surface and subsurface hydrologic transport as DOC. Hence, the question of scale controls on DOC sourcing and processing is fundamentally a hydrologic transport question. Here, we explored how DOC quantity and quality varied longitudinally along a forested mountain stream watershed as the seasonal flow decreased and went from fully connected in June 2016 to spatially intermittent surface flows in August 2016. We hypothesize that as flows decrease and intermittency increases, the importance of local scale stream-groundwater exchange processes will become the dominant scale controlling the quantity and quality of DOC in the stream and exported from the watershed. We further hypothesize that the DOC properties will shift from allochthonous (aromatic and high molecular weight) to more autochthonous (less aromatic and low molecular weight) as residence time and microbial processing of carbon will increase under low and intermittent flow conditions. Across three sampling events in June, July, and August, the flow exiting the watershed was 4.1, 1.6, and 0.5 L s-1, respectively. The stream surface flow was continuous during the June and July sampling events across the 595 m study reach. During the August sampling event, there were 26 intermittent sections, representing 18.2% of the total reach length. Across all sampling dates, the DOC concentration decreased from upstream to downstream consistent with uptake and transformation in the stream and valley bottom. As flow intermittency occurred, the mean DOC concentration in the stream nearly doubled from 1.09 to 2.06 mg L-1, and variance in DOC concentration (as standard deviation) nearly tripled from ±0.15 to ±0.42 mg L-1. DOC quality—characterized by the optical metrics of SUVA254 and spectral slope ratio—also shifted from more to less aromatic and from higher to lower molecular weight as the stream became intermittent. To evaluate the spatial scales that control DOC in the stream, we compared the upslope accumulation area (UAA) of the watershed to

each stream DOC concentration and quality measurement location. The correlation between UAA and DOC quantity and quality decreases as stream flow decreases and is weakest during flow intermittency. This decoupling of stream DOC from UAA combined with the shift of stream DOC to lower aromatic fractions and molecular weights suggests that stream DOC becomes increasingly dominated by local valley bottom and stream-groundwater processes when flow decreases and intermittency occurs. This study further suggests that the hydrologic regime in mountainous watersheds is key to understanding the spatial scales of sourcing and processing of DOC, with a threshold shift from catchment to local scales when spatial flow intermittency occurs.

Reconciling drainage basin and landscape approaches to improve water quality

Gilles Pinay Benjamin W. Abbott Florentina Moatar Camille Minaudo Gérard Gruau

OSUR-CNRS-University of Rennes 1
Presenter: Dr Gilles PINAY
Type of Presentation: ORAL

Abstract
Investigating the effect of land use on water quality at the catchment scale goes back decades. Recent land cover and land use changes with increasing anthropogenic pressure on water resources have occurred at a planetary scale, leading to water quality degradation. The drainage basin appears as an appropriate landscape unit for modelling water and nutrient fluxes, according to well-defined boundaries, catchment physical characteristics (topography, pedology, geology, etc.) and measurable output. However, for drainage basins that are larger than few km2, spatially-explicit or mechanistic modelling of interactions between land use, catchment characteristics and water quality requires some degree of spatial lumping, hampering prediction and quantification of the effects of subtle spatial land use or land cover change on water quality. From a landscape perspective, riparian zones have long been considered buffer zones between the larger landscape and the stream corridor, acting as biogeochemical hot spots of nitrogen removal. However, riparian corridors are also zones of incredible spatiotemporal variability, which has been a major obstacle to scaling measured processes beyond the reach level. There is a pressing need to translate small-scale process understanding to larger-scale landscape units, particularly for inter-catchments comparison, but this requires quantifying the effects of different spatial configurations and physical characteristics on catchment water quality. In this context, we develop a conceptual framework that combines landscape-level topographic analysis, process based field investigations using biogeochemical proxies, and water retention time distributions to characterise landscape nitrogen removal capacity.

Small ecosystem engineers are major drivers of aquatic sediment respiration

Viktor Baranov 1,3 Joerg Lewandowski 1,3 Stefan Krause 2, Paul Romej 2

Leibniz-Institute of Freshwater Ecology (IGB)
Presenter: Viktor Baranov
Type of Presentation: ORAL

Abstract
Ecosystem engineers are organisms, whose impact on ecosystem functioning is large compared to their abundance and biomass. Classic examples of ecosystem engineers are burrowing organisms whose activity is affecting the sediment matrix and pore solutes in aquatic sediments; this is called bioturbation. Constant reworking of the sediment matrix and transport of solutes caused by activities of sediment-dwelling organisms are modifying habitats and resource availability. Despite that progress of studies on the interactions between the animal bioturbation and the sediment respiration was rather slow, mostly due to the existing methodological limitations. Conceptual framework, formulated by Mermelloid-Blondin and Rosenberg (2006) is suggesting that impact of bioturbation on the sediment biogeochemistry will be much larger in sediments with low hydraulic conductivities (diffusion-dominated) than in sediments with high hydraulic conductivities (advection-dominated). In order to test this hypothesis in application to the sediment respiration, we have used the resazurin-resorufin bioreactive tracer system, which allowed us to decouple respiration of the sediment of microbiota. Our work has shown that in diffusion-dominated sediments (organic rich lake sediments) bioturbator's (bloodworms, larvae of Diptera, Chironomidae) activity could increase sediment aerobic respiration by 300%. In addition to that, impact of the bioturbators on the diffusion-dominated sediments respiration is growing with increasing temperature. Total oxygen consumption (TOU) in such sediments is also increasing by about 50% in bioturbated sediments in comparison with uninhabited sediments. On the other hand, in advection-dominated sediments (sandy sediments from marine tidal flats, bioturbated by brittlestars) we have observed no increase in TOU, and only slight (25%) increase in aerobic respiration in the presence of bioturbators. It became evident that due to the high hydraulic conductivity of advection-dominated sediments, alteration in solutes and nutrient distribution are minimal, hence no increase in TOU occurs. Still, presence of bioturbators has increased aerobic respiration of the system (probably due to animals' own respiration and the burrow - associated microbiota), thus not increasing but re-structuring TOU.

Mesocosm experiment reveals potential changes of nutrient processing and stream metabolism due to drought scenarios in Alpine streams

Astrid Harjung (1), Tom Battin (2), Andrea Butturini (1), Elisabet Ejarque (3), Francesc Sabater (1), Jakob Schelker (3,4), and Masumi Stadler (4)

Universitat de Barcelona
Presenter: Ms Astrid Harjung

Type of Presentation: ORAL

Abstract
Hydrologic conditions are a major driver of nutrient processing in streams, but so far the consequences of droughts are mainly studied in Mediterranean and desert areas. However, the hydrologic regime of most Alpine headwater streams will include more drought periods due to climate change, as well as hydropower use and water abstraction. Hence, understanding of nutrient processing and stream metabolism in Alpine areas during drought periods is fundamental. We improved this understanding by performing a mesocosm experiment, which consisted of six flumes of 40 m length each. Equally distributed bed forms were built with a sand-leaf-litter mixture, in order to mimic the upper layer of the hyporheic zone. These flumes were fed by stream water pumped from the adjacent Alpine stream with different flow rates each, representing different drought scenarios. We measured dissolved organic matter (DOM) quantity and quality and inorganic nutrients in the laboratory, as well as in-situ with high frequency in order to capture diurnal cycles. Net ecosystem production was calculated from continuous oxygen data. Our results suggest that the nutrient processing and metabolism of Alpine streams will experience severe changes with drastically reduced discharge. These changes include highly stimulated primary production, which supplied low-discharge streams with labile carbon and increased nitrate uptake. However, this labile carbon supply led to a drop in oxygen concentrations due to heterotrophic respiration after two weeks. This finding implies that the duration of the drought period is important and longer drought periods might include a shift in the metabolic balance.

Gravel bars are sites of increased CO2 outgassing in headwater streams

Kyle Boodoo (1,2) Tom Battin (3) Jakob Schelker (1,2)

University of Vienna
Presenter: Kyle Boodoo
Type of Presentation: ORAL

Abstract
Gravel bars (GB) are common in-stream structures with relatively large exposed surfaces, capable of absorbing heat and possibly acting as a heat source to the underlying hyporheic zone (HZ). The distinctive mixing of groundwater and surface water within their HZ largely determines its characteristic physical and biogeochemical properties, including temperature distribution. To study thermal variability within GBs and its possible consequences for CO2 evasion fluxes we analysed high frequency spatio-temporal data for a range of stream and atmospheric physical parameters including the vertical GB temperature, in an Alpine cold water stream (Oberer Seebach, Austria) over the course of a year. We found the vertical temperature profiles within the GB to vary diurnally and seasonally with discharge. We extended our study to 13 other gravel bars of varying physical characteristics within the surrounding Ybbs and Erlauf catchments, conducting diurnal spot samplings in summer 2016. Temperatures within the active

hyporheic zone of the OSB, were warmer than both end members, surface water and groundwater >18% of the year, particularly during summer and spring months. Average CO2 flux from the GB was significantly higher than that of streamwater during summer and winter, with significantly higher temperatures and CO2 outgassing rates occurring at the GB tail as compared to streamwater and the head and mid of the GB throughout the year. Increased vertical transfer of heat to the active hyporheic zone, measured as vertical temperature gradients within the hyporheic zone were associated with increased CO2 evasion fluxes within the OSB, particularly during summer. This enhanced CO2 flux may result from the input of warmer CO2-rich groundwater into the HZ in autumn, while downward heat transfer in summer may enhance GB metabolism and therefore CO2 evasion. Furthermore, catchment CO2 outgassing fluxes significantly exceeded that of the stream, with higher diurnal CO2 outgassing fluxes observed for all 13 GBs within the Ybbs and Erlauf catchments as compared to their respective streams. We found DOC concentration did not significantly correlate to CO2 outgassing. Vertical temperature gradient as a measure of heat flux to the hyporheic zone explained ~55% and 69% of the variability in observed CO2 efflux from the OSB gravel bar (seasonal samplings during summer 2015 – winter 2016) and 11 catchment gravel bars (2 GBs excluded due to equipment malfunction) respectively. These results highlight the effect of temperature on physical and biochemical stream processes, particularly in cold-water streams, due to the occurrence of more frequent and intense warm temperature events, as well as altered flow regimes, likely consequences of climatic change.

EFFECTS OF HELOPHYTES ON SOLUTE TRANSPORT DYNAMICS ALONG SUBSURFACE FLOWPATHS IN ARTIFICIAL FLUMES

Myrto Nikolakopoulou Alba Argerich Jennifer D. Drummond Esperança Gacia Eugènia Marti Albert Sorolla Francesc Sabater

Naturalea - University of Barcelona
Presenter: MYRTO NIKOLAKOPOULOU
Type of Presentation: ORAL

Abstract
Helophytes are often used in constructed wetlands, and, more recently, in stream restoration efforts aimed to nutrient mitigation, since they actively uptake nutrients and their rhizosphere provides substrate to bacteria contributing to biogeochemical processes. However, little is known about the physical effects of helophyte root system on transient storage and solute transport. In the present study, we investigated the effect of three helophyte species with different root development, on solute transport along subsurface flowpaths. We hypothesized that root structure would modify solute flowpaths, and therefore transient storage would differ between helophyte species. The selected helophytes were Iris pseudacorus L., Phragmites australis L., and Scirpus lacustris L., as the most commonly used species in river restoration and in constructed wetlands. We performed conservative tracer

(chloride) pulse additions in a set-up of 12 flow-through artificial flumes subjected to four different treatments with three replicates: absence of helophytes (control), and presence of Iris, Scirpus, and Phragmites. To characterize transport within the flumes, we estimated hydraulic parameters by fitting water chloride concentration profiles to a mobile-immobile model. We characterized helophyte root structure by collecting a ~30 L sediment-with-roots sample from each flume and separating root fractions to fine roots and rhizomes. Solute transport differed among the treatments, resulting in mean water residence times of 2.5 times, 2 times, and 1 time longer in Phragmites, Scirpus, and Iris respectively, than residence time in the control. Furthermore, high variability of hydraulic parameters within each treatment was observed, which can be explained by the effect of weather conditions on the flumes' evapotranspiration or evaporation rates. Root structure differed between the species with up to 4 cm, ~1.5 cm, and ~0.5 cm rhizome diameter for Iris, Scirpus and Phragmites respectively. Our results from the artificial flumes suggest that the root structure of helophytes, as well as evapotranspiration, affect solute transport and transient storage, and this can be added value to understanding the controls of hyporheic transport in streams.

Stable spatial structure and strong temporal synchrony of water quality in stream networks

B. W. Abbott1,2, G. Gruau3, J. Zarnetske1, F. Moatar4, Lou Barbe2, Z. Thomas5,6, O. Fovet7,5, T. Kolbe3, S. Gu3, A.C. Pierson-Wickmann3, Philippe Davy3, G. Pinay2

Presenter: Dr Ben Abbott
Authors: **Institution:** Michigan State University and OSUR, CNRS
Type of Presentation: Oral

Abstract
To feed nine billion people in 2050 while maintaining viable aquatic ecosystems will require an understanding of nutrient pollution dynamics throughout stream networks. Most regulatory frameworks such as the European Water Framework Directive and U.S. Clean Water Act, focus on nutrient concentrations in medium to large rivers. This strategy is appealing because larger systems integrate many small catchments and from an estuarine or oceanic perspective, total nutrient loads drive eutrophication. However, there is growing evidence that to understand and reduce downstream nutrient fluxes we need to look upstream. While headwater streams receive the bulk of nutrients in river networks, the relationship between land cover and nutrient flux often breaks down for small catchments, representing an important ecological unknown since 90% of global stream length occurs in catchments smaller than 15 km2. Though continuous monitoring of thousands of small streams is not feasible, what if we could learn what we needed about where and when to implement monitoring and conservation efforts with periodic sampling of headwater catchments? To address this question we performed repeat synoptic sampling of 56 nested catchments ranging in size from 1 to 370 km2 in western France over 12 years. Spatial variability in carbon and nutrient concentrations was high between very small catchments but collapsed moving downstream, with

variance thresholds occurring between 36 and 68 km2. While it is widely held that temporal variability is higher in smaller streams, we observed a separation of temporal signals for subcatchment smaller than the spatial variance threshold, with as many low variability subcatchments as high. Furthermore, because water chemistry responded synchronously to hydrological variability, the ranking of catchments based on water quality was stable at seasonal and interannual timescales. We used these observations to develop two simple management frameworks. The subcatchment leverage concept proposes that mitigation and restoration efforts are more likely to succeed when implemented at spatial scales expressing high variability in the target parameter, which indicates decreased system inertia and demonstrates alternative system responses are possible. The subcatchment synchrony concept suggests that periodic sampling of headwaters can provide valuable information about pollutant sources and inherent resilience in subcatchments even in the absence of costly high-frequency monitoring. Overall, if agricultural activity were redistributed based on this assessment of catchment vulnerability to nutrient loading, water quality could be improved while maintaining crop yields.

Runoff generation processes inferred from surface water network dynamics

Marta Antonelli (1,2) Barbara Glaser (1) Julian Klaus (1) Adriaan J. Teuling (2) Laurent Pfister (1)

Luxembourg Institute of Science and Technology (LIST)
Presenter: Marta Antonelli
Type of Presentation: ORAL

Abstract

Runoff generation processes are widely studied in hydrological sciences. The complexity of the rainfall-runoff process is largely due to the multitude of water sources and flowpaths, as well as the large spatial and temporal variability of runoff contributing areas. The documentation of expansion and contraction dynamics of stream networks, as well as of saturated area connectivity in the riparian zone, has led to significant progress in our understanding of runoff generation processes. Perhaps even more interestingly, the documentation of these dynamics might actually mirror subsurface processes. Despite the widely recognised value of surface water dynamics (also given their important connection with ecological and biogeochemical characteristics of catchments), research has been rather scarce. Here, we rely on a combination of different techniques for investigating the spatial and temporal variability of runoff generating areas along the hillslope-riparian-stream continuum. We carried out our observations over a period of 18 months in the schistose forested Weierbach catchment (0.45 km2) in Luxembourg. We used a handheld thermal infrared (TIR) camera to monitor nine saturated areas within riparian areas and the subsequent on- and offset of their connectedness to the stream network. During our fortnightly TIR image acquisitions, the active stream network length was also manually mapped. We carried out monthly discharge measurements at 12 different locations (i.e. upstream and downstream of each

saturated area) in order to identify gaining and losing reaches of the stream. Precipitation, stream discharge at the outlet, groundwater level and soil moisture time series were also recorded. Our preliminary results document a distinct heterogeneity in hydrological regimes of various stream reaches. Some of them contributed to runoff mainly during wetting-up periods, while others contributed essentially during recession periods. This may be indicative of hysteresis effects at scales smaller than sub-catchment scale, which are often not considered in rainfall-runoff models. We hypothesize that this spatial heterogeneity in hydrological responses might be driven by differences in the steepness of the hillslopes contributing to the various reaches. Variations in the active stream length can be related to variations of the total stream discharge at the outlet, while changes in the amount of riparian saturation are mainly related to the amount of contribution to total runoff by the corresponding stream reach. However, this phenomenon is visible at different degrees in the different locations, pinpointing towards a variability in the development of saturation in different areas (i.e. areas with similar or different morphological or topographic characteristics).

Topographical versus geological controls of groundwater residence times to streams

J.-R. de Dreuzy1, S. Leray2, J. Marçais1, Q. Courtois1, T. Kolbe1, G. Pinay3, L. Aquilina1, T. Labasque1

CNRS, University of Rennes 1
Presenter: Jean-Raynald de Dreuzy
Type of Presentation: ORAL

Abstract
While controls of topography and geology have been extensively discussed on flow structures and aquifer dynamics, consequences on residence times have only been more recently questioned. Recent advances in the development of several environmental tracers have given a wider access to the wide diversity of residence times and to high mixing effects in convergence zones like streams. Based on several study sites in crystalline aquifers of Brittany (France), we investigate the relations between flow structures and residence time distributions. If extremely long residence times are evidently linked to deep aquifer and very short transit times to surface transfer processes, the month to century transit times are controlled by dynamical interactions between surface and subsurface processes with especially broad distributions in hyporheic and riparian zones. We show that simple lumped parameter models can efficiently be used as a first approximate way to capture the time distribution. As the question is not so much the residence times by themselves but their relation to groundwater resource evaluation and overall groundwater quality, we discuss potential applications to continental scale studies of residence times. We argue that large-scale studies still require further development of innovative tracers over the month to decade time scales.

Hydrologic Controls on Hyporheic Oxygen Dynamics around In-stream Features

Michael Vieweg (1) Jan H. Fleckenstein (1) Christian Schmidt (1)

Helmholtz Centre for Environmental Research - UFZ
Presenter: Tanja Brandt
Type of Presentation: ORAL

Abstract
In-stream gravel bars are increasingly recognized as distinct zones of elevated biogeochemical reactivity, especially in response to hydrologic variability and events. Here, oxygen may serve as proxy for aerobic metabolism as well as indicator for aerobic zonation. We combined recent technology for automated in situ oxygen profiling with monitoring of pressure, temperature and the natural electric conductivity (EC) signal to specifically disguish between hydrologic and biological controls of biogeochemical reactivity. Beyond characterizing general patterns of the spatial-temporal oxygen distribution within these features, we specifically focused on the effect of hydropeaks. Our results clearly revealed distinct oxygen variability across both scales, spatially along the vertical oxygen profile as well as temporally at discrete depths, revealing distinct reactivity zones. The observed variability exhibited a high degree of small-scale heterogeneity at the hourly and cm scale. Specifically we could track a lagged diel stream oxygen signal in a narrow zone at approximately 45 cm sediment depth. This pattern likely relates to observed differences of travel times, indicative of a preferential flow path, horizontally circumflowing a hyporheic flow cell. The dominance of the horizontal flow component could also be observed in the upper part of the generally anoxic flow cell during hydropeaks as indicated by decreasing lag times of reoxygenation patches with depth. Overall, high-resolution oxygen profiling sufficiently captured small-scale variability and heterogeneity during baseflow conditions as well as hydrologic events.

Streambed heterogeneity drives microbial metabolic activity through residence time

Paul Romeijn, Rebwar Dara, Stefan Krause, David Hannah

University of Birmingham
Presenter: Paul Romeijn
Type of Presentation: ORAL

Abstract
The streambed and the hyporheic zone are often characterised by sharp gradients in hydraulic conductivity. These sharp gradients have implications for organic carbon, dissolved oxygen and nitrate turnover in the shallow hyporheic zone. Low-conductivity sediment structures in the streambed can inhibit groundwater

upwelling and cause local surface water downwelling, including horizontal pore water flow. These often very local differences cause variability in residence time and provide a place for small-scale differences in microbial activity and their associated turnover. We used a novel small scale “push-pull” tracer application, using the Resazurin-Resorufin tracer system to measure microbial metabolic turnover. The tracer was injected at discrete depths in a UK lowland river strongly impacted by surrounding agriculture that was previously surveyed using ground penetrating radar. This approach provided us with a combined measurement of dilution and a relative comparison for microbial metabolic activity between locations. We found residence time related differences in microbial metabolic activity as measured by Resazurin turnover. Our results suggest microbial metabolic activity is driven by a combination of dissolved oxygen, nutrient supply and residence time. In heterogeneous streambed environments we expect strong variations in nutrient attenuation. These variations may have large impacts on predicting spatial patterns of nutrient attenuation, microbial activity and associated greenhouse gas production in the hyporheic zone.

S3 Multi-stressor interactions and impacts on ecohydrological process dynamics

Ursula McKnight

Abundant benthic microbial mats in harsh stream environments: underlying hydrologic, biogeochemical and ecological controls

Diane McKnight Michael Gooseff Garrett Rue

Presentor: Diane McKnight
Type of Presentation: Oral

Abstract
Stream ecosystems can be subjected to multiple hydrologic and biogeochemical stressors due to physical and climatic conditions and due to anthropogenic disturbance. In stream ecosystems where the stressors are severe enough to eliminate upper trophic levels, e.g. fish and benthic invertebrates, benthic microbial mats can become abundant. These mat communities may be dominated by microbial taxa that are not only adapted to survive the harsh conditions but are also able to maintain ecosystem function through accumulation of biomass in the absence of grazing pressure. In this presentation, examples will be considered of ecological function of microbial mats in glacial meltwater streams in the McMurdo Dry Valleys, Antarctica and in acid rock drainage streams in the Rocky Mountains, USA. In the Dry Valley streams, perennial cyanobacterial mats are freeze-dried through the winter and begin to photosynthesize within minutes of the onset of streamflow. Accumulation of mat biomass is controlled by the hydrologic regime, with limited growth occurring in cold summers with short periods of streamflow and loss of mat biomass due to scouring occurring during flood events. By conducting nutrient addition tracer experiments, we have shown that these abundant mats regulate nutrient fluxes through uptake and remineralization of mat biomass trapped in the hyporheic zone. Acid rock drainage streams, which are common throughout the Rocky Mountains, support microbial mats that are dominated by taxa that are tolerant of the high dissolved concentrations of toxic metals, such as zinc, lead and cadmium, and low pH values. The physical stressors that control the abundance of benthic algal mats in these streams is the deposition of metal oxides on the streambed surface. An additional stressor for these mats is the limited availability of phosphorus due to the strong sorption of phosphate by the iron oxides on the streambed. The results of an experimental addition of 32P- enriched phosphate to an acid mine drainage stream showed that the algal adapted to maximize uptake of phosphate during the mid-day when photo-reductive dissolution of the iron oxides released dissolved phosphate to the water column. These examples illustrate that multiple hydrologic and biogeochemical processes act as bottom up controls influencing the function of stream ecosystems in harsh environments.

Drivers of microbial metabolic activity, biogeochemical cycling and associated greenhouse gas production in streambed sediments

Sophie Comer-Warner Stefan Krause Daren Gooddy

University of Birmingham

Presenter: Sophie Comer-Warner
Type of Presentation: ORAL

Abstract
Hotspots of enhanced biogeochemical reactivity are produced where groundwater and surface water mixes in streambed sediments. This enhanced reactivity is due to elevated residence times and nutrient concentrations found in these areas, leading to increased rates of microbial metabolic activity. Streambed sediments, therefore, may be important in reducing catchment wide nutrient concentrations through increased cycling. However, they also have the potential to produce high concentrations of greenhouse gases (CO2, CH4 and N2O) as end-products of respiration and denitrification. The hydrological and biogeochemical drivers of streambed C and N cycling, are still insufficiently understood; this study aims to address this lack of understanding through the investigation of multiple environmental controls, such as, temperature, sediment type and residence time.

Altered oxygen dynamics in the sub-surface environment under urbanization: consequence for nutrient pathways.

Carolyn E. Oldham(a,c), Carlos J. Ocampo(a,c), Tanveer M. Adyela (b,c) and Matthew R. Hipsey(b,c)

The University of Western Australia
Presenter: Prof Carolyn Oldham
Type of Presentation: ORAL

Abstract
Urbanization creates an array of sub-surface stormwater pipes and infrastructure that can create preferential flow paths, often referred to as urban karst, producing an altered hydrological environment. In areas where this intersects high groundwater, whether permanent, seasonally perched or temporarily perched due to storm events, the rapid flow pathways create oxygen concentrations in sub-surface flows that can be significantly different to those in undisturbed landscapes. In areas where storm flow infiltration is rapid, transport of stormwater along the preferential flow pathways may inject oxygen into the sub-surface environment, creating more oxic conditions than found in the undisturbed environment. Alternatively, if the new sub-surface flow paths intersect soil organic matter and soils of lower permeability, infiltrating stormwater may increase soil saturation and create lower oxygen concentrations than expected in the sub-surface flows. This perturbation of oxygen conditions due to infrastructure development or altered urban hydrology can impact nutrient transformation pathways, and ultimately how we manage urban nutrients. We present field data from several urban study sites in the city of Perth, on the Swan Coastal Plain, in Western Australia. The area experiences a Mediterranean climate with long hot dry summers and wet cool

winters. Historically wetlands dominated the coastal plain, which is an exposed ancient sandy seabed. Wetlands formed where the inter-dunal depressions intersected high groundwater, however over the past 150 years of urbanization, more than 95% of the wetlands have been drained, leaving pockets of duplex soils, often with high organic matter, scattered across the sandy plain. Seasonal variability in groundwater height results in these geological wetland soils being seasonally saturated and then dried. Urbanization of this area has superimposed an urban karst onto this system. We show that where urban development has led to increased high nutrient and low oxygen groundwater intercepting stormwater systems, this low oxygen water flows into constructed wetlands, strongly perturbing the wetland ecology and leading to decreased nutrient attenuation. In contrast, data from urban biofiltration systems show that the rapid injection of oxygen-rich storm flows into the subsurface during storm events shifts the balance of nutrient attenuation. Our results suggest that when designing urban stormwater systems, particularly in areas with sandy soils, high permeability and high groundwater, careful attention should specifically be paid to optimizing oxygen conditions. Designing systems to create hydrological pathways and conditions to manipulate oxygen levels, will allow optimization of nutrient attenuation and protect downstream receiving waters.
Acknowledgements: This study was funded by the Cooperative Research Centre for Water Sensitive Cities, Australia under subproject B2.4 “Hydrology and nutrient transport processes in groundwater/surface water systems”.

Climate change impact on riverine nitrous oxide emissions across biomes

Alessandra Marzadri(1), Daniele Tonina(1), Alberto Bellin(2), Martha Dee(3), Jennifer Tank(3), Susana Bernal(4)

Center for Ecohydraulics Research, University of Idaho
Presenter: Alessandra Marzadri
Type of Presentation: ORAL

Abstract
Future climate predictions forecast more frequent and severe extreme events, droughts and flooding, than historically recorded in most parts of the world. Droughts and floods may combine in a nonlinear manner with direct anthropogenic effects, such as an increase in nutrient loading to streams, possibly amplifying climate change impact on freshwater ecosystems. Expected future droughts may last longer and become more frequent than present, with currently unknown effects on biogeochemical processes in streams and rivers, which may lead to an increase of emissions of nitrous oxide (N2O), a potent greenhouse gas (GHG) that contributes to stratospheric ozone destruction. Anthropogenic inorganic nitrogen loading to river networks is a potentially important source of this gas to the atmosphere via microbially-mediated denitrification of reactive nitrate (NO3) to N2O and dinitrogen (N2) gas. Estimates of watershed-scale N2O emissions are highly uncertain because of the difficulties in scaling local measurements to the river network. Here, we apply a scaling law to investigate the impact of climate change on riverine N2O emissions from two Midwestern US river networks flowing in a temperate region, and

compare these to a Mediterranean river network flowing in a sub humid region. Given the spatial variability of NO3- concentrations along the stream network, the scaling law allows us to characterize N2O emissions from riverine processes occurring in the water column, benthic and hyporheic zones. We compared N2O emissions predicted with measured data collected along these watersheds and then used the scaling law to show the effect of droughts on N2O emissions. We show how the spatial distribution of dissolved inorganic nitrogen and N2O emissions change along the analyzed stream networks by comparing the behaviors of streams of different biomes , sizes, and with contrasting land use.

Intersecting threats of climate change and river basin fragmentation in the Central Great Plains of the United States

Melinda D. Daniels Sarmistha Chatterjee

Stroud Water Research Center
Presenter: Melinda Daniels
Type of Presentation: ORAL

Abstract
The semi-arid Central Great Plains regions of the United States experiences cyclic decadal extreme droughts on decadal scales and extremely variability annual flow regimes. The native fish community has evolved life history traits including pelagic spawning and seasonal migration that accommodate extensive stream network desiccation. However, humans have severely fragmented these networks with extensive damming and climate change projections suggest amplification of flow regime extremes. Recent historical records show dramatic declines in native fish populations in the last 60 years, coinciding with the initiation of damming in the region, yet the number and location of these dams is undocumented. In this study, we first document the extent of stream network fragmentation of two large river networks via digitization, the Smoky Hill and Neosho, quantify the degree of network connectivity using the Dendritic Connectivity Index. Secondly, we overlay analyses of the flow regime to demonstrate how dam fragmentation results in network isolation during and following extreme drought, permanently limiting the habitat accessible to fish. Finally, using six climate scenario models, we project the effects of climate change on future flow regimes in the region with implications for native fish populations.

Re-evaluating multi-stressor interactions: novel insights advancing stream ecosystem impact assessments

Ursula S. McKnight 1 Anne T. Sonne 1 Jes J. Rasmussen 2 Vinni Rønde 1 Walter Traunspurger 3 Sebastian Höss 3,4 Poul L. Bjerg 1

Department of Environmental Engineering
Presenter: Ursula McKnight
Type of Presentation: ORAL

Abstract
Increasing modifications regarding land use, land cover and water management driven by urban expansion and increased agricultural production have resulted in multiple stressors impacting freshwater ecosystems on a global scale. To date emphasis has been on separating and quantifying the degree of impact an individual chemical stressor may have on aquatic health – driven in large part by legislation like the European Water Framework Directive. However, this might not give a holistic overview of the situation, leading potentially to errors in determining ecological status. Moreover, a stream system impacted by multiple stressors has a high chronic stress level, so even small perturbations on top of changes in water flow or additional chemical stressors may be detrimental to stream health. The large number of micropollutants (pharmaceuticals, chlorinated solvents, pesticides/biocides, nutrients, heavy metals), their transformation products and their sources makes the quantification of their occurrence and toxicity a challenging task. Conventionally, chemical impacts to ecosystems are assessed individually or one source type at a time. We presume this will give us a good indication of the impact of a particular stressor. Our hypothesis, however, is that this leads to underestimations of the combined impact caused particularly by interactions occurring between stressors not typically evaluated together, e.g. xenobiotic groundwater pollutants and metals. To address this issue, we identified sources and levels of chemical stressors along a 16-km groundwater-fed stream corridor (Grindsted, Denmark) and linked the chemical impact to stream water quality. Potential pollution sources included two contaminated sites (factory, landfill), aquaculture, wastewater/industrial discharges, and diffuse sources from agriculture and urban areas. Data for xenobiotic organic groundwater contaminants, pesticides, metals, general water chemistry, physical conditions and streamflow from three campaigns (2012-2014) were assessed. Toxic potentials were estimated for relevant chemical groups using the toxic units (TU) approach. Ecological status was determined by monitoring meiobenthic and macrobenthic invertebrate communities. The results show a substantial impact on Grindsted stream from multiple sources of many origins. The stream was substantially impaired by both geogenic and anthropogenic sources of metals throughout the investigated corridor, with concentrations close to or above threshold values for barium, copper, lead, nickel and zinc in the stream water, hyporheic zone and streambed sediment. The groundwater plume from the factory site caused elevated concentrations of chlorinated ethenes, benzene and pharmaceuticals in both the hyporheic zone and the stream, persisting for several km downstream of the discharge area. The calculated TU was generally similar along the stream, but for arsenic and nickel higher values were observed where the groundwater plume discharges into the stream. Ecological results indicate a change in community composition for benthic invertebrates, pointing towards the presence of localized “ecotoxic risk zones” characterized by synergistic impacts of discharging contaminated groundwater and metal contamination. We suggest that these zones are additionally impacted by the strongly reduced water – characterized by high concentrations of iron and

manganese – created by the degradation of xenobiotic compounds, leading to the increased release of arsenic and nickel that may be contributing to the ecotoxicity.

Impact of overland flow, macropore flow, and matrix flow on N and P dynamics in artificially drained lanscapes of the US Midwest.

Philippe Vidon

SUNY-ESF
Presenter: Philippe Vidon
Type of Presentation: ORAL

Abstract
Storm losses of nitrogen (N) and phosphorus (P) in agroecosystems of the US Midwest are a major concern for water quality in the Mississippi River Basin (MRB). A better understanding of processes regulating both N and P exports to streams and tile-drains in the US Midwest is therefore critical to minimize N and P losses from agricultural fields while maintaining crop yield. This study investigates N and P dynamics at a high temporal resolution during 8 spring storms in stream flow, overland flow and two tile-drains in the US Midwest. Storm NO3, NH4, DON, SRP and TP fluxes and concentrations are examined in relation to tile-drain flow and macropore flow contributions to tile and stream flow. Results stress the importance of macropore flow over matrix flow and/or overland flow in regulating N and P losses to streams, as well as the non-linear behavior of N and P losses to streams during spring storms in artificially drained landscapes of the US Midwest.

Multiple stressors affect ecological stream communities involved in organic matter processing

Jes Jessen Rasmussen Daniel Gräber Tenna Riis Tinna Mia Jensen Mathias Joachim Skov Pristed Annette Baattrup-Pedersen

Aarhus University
Presenter: Jes Rasmussen
Type of Presentation: ORAL

Abstract
The ongoing climate change and the increasing exploitation of land and resources by the human population generate complex combinations of stressors acting in congruence on biological communities. Effects of multiple stressors appear to be particularly strong in freshwater ecosystems which experience declines in biodiversity exceeding those of terrestrial and marine ecosystems. In spite of increasing focus on multiple stressors in environmental sciences, a vast majority of studies addressing stressor effects on ecological communities focus on single stressors and on single organism groups, usually macroinvertebrates. Yet, to more fully understand effects of anthropogenic and climate driven stressors on stream ecosystems, it is imperative to include several taxonomic groups at different trophic levels and, in addition to traditional structural measures, to include also measures of ecosystem function. Variability in sedimentation patterns, flow, and nutrients are

inherent characteristics of fluvial systems, but today the natural variability in these is exceeded in many systems and they therefore act as stressors with strong impacts on stream biodiversity and ecosystem processes. These stressors reach critical levels due especially to agricultural practices but are further reinforced as a consequence to climate change. We used semi-natural stream channels, open to colonisation, to examine individual and interactive effects of sedimentation, low-flow events, and increased nutrient concentrations on macroinvertebrate and leaf-decomposing fungal communities, as well as the related ecosystem function (organic matter decomposition). Using this experimental set-up we were able to quantify effects of single stressors as well as stressor combinations and, for the first time reveal some fundamental mechanisms which reinforce the propagation of effects through the food chain.

Evaluating stream water quality and ecological integrity in the context of impairment and conservation within the Delaware River watershed

Marie J. Kurz Stefanie A. Kroll David J. Velinsky

Academy of Natural Sciences of Drexel University
Presenter: Marie J. Kurz
Type of Presentation: ORAL

Abstract
Spatial and temporal patterns in stream water chemistry and ecological integrity are being investigated to evaluate impairment and quantify the impact of coordinated, large-scale land protection and restoration efforts within the Delaware River Watershed, USA (36,570 km2). These efforts are the result of the Delaware River Watershed Initiative (DRWI), a collaborative conservation program with the goal of maintaining and improving stream water quality and ecological integrity locally and in the larger Delaware River watershed. DRWI focuses on 8 unique sub-watershed "clusters" encompassing the continuum of watershed landscapes, from pristine headwaters to agricultural areas to urban centers, and impacts from a range of key stressors including loss of forested headwaters, agricultural run-off, and polluted stormwater. Two types of stream sites are being studied in order to 1) establish baselines against which to evaluate future changes in stream water quality and ecological integrity resulting from conservation efforts, 2) evaluate spatial-temporal patterns and controls on stream water quality, biotic indicators of ecological integrity, and habitat, and 3) guide adaptive, science-based management of current and future projects and objectives. Since 2013, 35 "integrative" sites, chosen to represent the land use and stream conditions within each cluster, have been sampled quarterly for water chemistry and bi-annually for in-stream communities (incl. algae, macroinvertebrates and fish) and habitat assessment. Within this timeframe, additional "project" sites, located at or directly downstream of DRWI conservation projects, have also been sampled for water chemistry and biotic indicators. Initial results show clear regional patterns in major water chemistry parameters, which are broadly correlated to watershed surface geology and land use. Seasonal variability, where present, is consistent with processes such as winter

road salt application and increased growing-season nutrient retention. Similarly, in-stream communities and habitat integrity are correlated to watershed land use and regional geographic distributions of species. Further analysis will investigate these correlations, and projected impacts of restoration and protection projects, in more detail.

The state of ponds of Manipur Valley in Northeast India in view of changing time

Kshetrimayum Krishnakanta Singh

Assam University, India
Presenter: Kshetrimayum Krishnakanta Singh
Type of Presentation: ORAL

Abstract
The Manipur valley is located as an intramontane basin filled with alluviums of fluvio-lacustrine origin of Quaternary age in the Indo-Myanmar Range of Northeast India. The valley is confined between 24°16' and 25°2' North latitudes and 93°41' and 94°9' East longitudes covering an area of ~1920km2 with a population of more than 2 million people. This valley is mainly occupied by ponds, wetlands, rivers, lakes, agricultural fields, flood plains and hillocks. Culturally the ponds have been an important part of the society of the people living in this valley since the first century. Historically, these ponds were emotionally related to cultural and ritual activities, fortification and recreational activities since the beginning of the Manipuri culture. Presently, the ponds are used mainly for domestic, irrigation, industrial water supply and fish production only and thus creating a cultural gap in the Manipuri society as the ritual activities around these surface water bodies are no more practiced. Though, the role of a pond in the Manipur society is manifold and makes an absolute contribution to daily life, they have been a victim of serious scientific and social negligence. The rapid urbanization, massive increase in population, local climate change and shrinkage of wetlands cause significant diminishing of ponds in the valley. Currently, ponds occupy an area of only 6.8 km2 which is 0.35% of the total area of the valley. Mismanagement and negligence on the treatment of domestic solid waste deteriorate the quality of the pond water. Also, artificial eutrophication coupled with climate change as it reduces oxygen level and increases acidic level in the pond water further worsen the quality leading to the extinction of some fish species from the pond water. Therefore, it is high time to avoid demolishing ponds and rejuvenate them to maintain the age-old socio-cultural relationship it bears. The best will prevail if and only if we pay them the best tributes now and hail their importance with the purest of intentions.

Characterisation of river temperature heterogeneity at the regional scale: influence of vegetation, small weirs and stream-aquifer exchanges

Pierre LOICQ Florentina MOATAR Yann JULLIAN David M. HANNAH

Université de Tours (France)

Presenter: Pierre LOICQ
Type of Presentation: ORAL

Abstract
Water temperature affects fish behaviour and survival, and thus possibilities of anthropogenic releases of warmed water. Water temperature is already increasing and is expected to increase further due to climate change. In this context, riparian shade, stream-aquifer exchanges, and weirs have a key role in the regulation of water temperature, especially in summer. The goal of the present work is to analyse the influence of these three factors in the Maine catchment (France). This watershed of 22350 km^2 is composed of the Mayenne, the Sarthe and the Loir catchments, whose area are similar. It is contrasted in term of hydrogeology since the west part is composed of shale, while the east part is made of permeable limestone. More than 1200 small weirs (<5m) are present on the Maine catchment. Their density is also variable: the tiering rate does not exceed 30% in the west while it rises up to 60% in the east part. Temporal and spatial evolution of temperature has been modelled with T-NET (Beaufort et al., 2016), a physically-based model using the equilibrium temperature concept and including upstream-downstream propagation of the thermal signal. Computations are made every hour and at each confluence. The median length of the 10000 reaches is 1.4 km. 44 temperature sensors located on the catchment provide hourly measures between 2008 and 2015. 36% of these sensors were classified as being impacted by stream-aquifer exchanges, and are located both in aquifer and non-aquifer area. Their average annual amplitude is 9°C, while it reaches 16°C for the 12 sensors classified as being not impacted by groundwater exchanges. Groundwater fluxes modelled at a 1-km resolution (Baratelli, 2016) were used as input of the T-NET model to improve its accuracy in the aquifer area, and confirm the information provided by the sensor network. Thanks to lidar-derived data, we used a spatially-explicit method to precisely compute the impact of riparian trees on the direct and diffuse solar radiation and the water temperature of 270 km of the Loir River. Compared to two methods that can be easily applied at the regional scale, the use of lidar data improves the mean value of the maximum daily temperature simulated by the T-NET model between April and September. However, the variability of simulated daily maximum temperatures and hourly temperatures, which is more important than observations, is not improved. The impact of the weirs on the water depth and on the transfer time has been included in T-NET thanks to a national dataset. On average, it improves the daily amplitude as well as the variability of simulated temperature.

S4 Aquatic Ecology - Quantitative analysis of interactions between hydrological and biological processes

Paul Wood

Repurposing flow-ecology tools for environmental flows assessment in cold regions

Wendy A. Monk Zacchaeus G. Compson Daniel L. Peters R. Allen Curry Donald J. Baird

Canadian Rivers Institute, University of New Brunswick
Presenter: Dr Wendy Monk
Type of Presentation: ORAL

Abstract
With growing global pressures and increasing climatic variability, the development and application of new and emerging tools to support integrated water management is critical to sustain water resources. Environmental flows approaches (e.g. Ecological Limits Of Hydrological Alteration) have favoured a synthesis of available scientific information directed at ecologically-based, socially-acceptable flow targets at watershed- and regional-scales. The tools supporting these holistic approaches apply knowledge of how prevailing flow regimes and their intra and inter-annual variability structure habitats and aquatic communities in river ecosystems. This assumes that changes to this natural hydrological variability via both long-term (e.g. climate change, hydropower development) or short-term (e.g. seasonal water abstraction; climate extremes) flow alterations can degrade ecological condition. However, formal assessment of these flow alteration-ecology relationships is limited both by a lack of large-scale, long-term, standardised monitoring data, and by the need to extrapolate in unknown regions. To address this challenge, we present a case study of the early development of a holistic environmental flows framework for the regulated Saint John River watershed (New Brunswick, Canada) and introduce analytical tools tailored to management strategies in cold regions. First, we note that the traditional suite of ecologically-relevant hydrological variables used in flow-ecology assessment ignores the influence of winter ice cover and the spring freshet on hydrological regimes. Conditions during freeze-up, ice cover and subsequent break-up are key components of river systems, directly influencing water quality, aquatic and riparian habitat and ecology in cold regions. We present a spatial and temporal assessment of flow alteration using cold region-specific hydrological variables for both natural and regulated sites within the Saint John River watershed. Second, we introduce a proposed functional flow-ecology index based on prior knowledge of biological trait modalities. Large-scale flow-ecology associations, as quantified by both traditional taxonomic and trait modality information, are explored using a consistently-observed, matched dataset of average flow velocity and benthic macroinvertebrate community occurrence spanning a large longitudinal and latitudinal gradient. At continental scale, as predicted, taxon data exhibited greater signal to noise ratio along the flow velocity gradient while the trait responses were more stable and predictable. Trait modalities consistent in their

responses to flow velocity were incorporated in a functional flow-ecology index and were compared with a traditional taxon-based structural flow-ecology index. Both indices were evaluated within different flow habitats within the Saint John River watershed to assess flow alteration-ecology hypotheses within the environmental flows framework. The development of watershed-scale environmental flows frameworks has the potential to match the scale of protection and recovery of a freshwater ecosystem, aligning with the needs of complex water management scenarios involving multiple competing ecosystem services. However, although flexible, such strategies should be regionally tailored, using evidence-based flow targets derived from a knowledge of predictable flow-ecology responses. This initial evaluation of an environmental flows strategy for the Saint John River has demonstrated the importance of incorporating regional-scale knowledge and tools to generate adaptively managed outcomes.

Impacts of Hydrodynamics on the Behavioural Response of the Endangered Freshwater Pearl Mussel (Margaritifera margaritifera)

1 - Ed Curley 2 - Rhian Thomas 3 - Colin Adams 4 - Alastair Stephens 5 - Iain Sime 6 - Ian Milne

University of Glasgow
Presenter: Dr Rhian Thomas
Type of Presentation: ORAL

Abstract
The freshwater pearl mussel M.margaritifera is an endangered and protected species and although Scotland is a global stronghold, populations are in decline. Many factors have contributed: flow alterations due to abstractions and hydroelectric schemes, declines in salmonid host stocks, sedimentation, poaching and pollution. The hydroelectric industry in Scotland is an important source of renewable energy, and with applications for small-scale schemes increasing, this sector is expanding rapidly. However, the impacts on flow regimes, fluvial geomorphology and resulting habitat of high conservation value species, such as the pearl mussel and salmonids, are not completely understood. Changing flow conditions affect river habitat and is generally understood that flood events can destabilise river beds through mobilisation of sediment and of mussels themselves. Low base flows can result in decreases in flow velocity over adult mussels that filter-feed, and through substrate interstices, detrimental as fine sediment and algae accumulate, decreasing oxygen, and increasing the risk of dessication. In addition, impacts of climate change on flow regimes in regulated and unregulated rivers, on both mussel and host fish, remain uncertain. Climate change scenarios suggest rainfall will become increasingly unpredictable and summer droughts more frequent and prolonged. Hence, our current understanding of flows that are ecologically relevant to maintaining M.margaritifera beds is poor and information about how changes in flow may affect mussels is data deficient. Research presented here are preliminary results from a project aimed at addressing these gaps,

providing knowledge currently lacking by investigating behavioural response of M.margaritifera to changes in flow regime, sediment and resulting impacts on habitat quality. Novel approaches have been adopted, including a series of experiments to quantify M.margaritifera stress responses; manipulative experiments utilising a laboratory-based flume with live mussels to monitor mussel response to changing flow regimes (gradual v's rapid increases and decreases in velocity), different substrate types and complexity, and varying mussel population clusters (individual v's groups) at different stages of mussel development (juvenile to adult). MSc research conducted in 2013 provides proof of concept of the experimental approach and pilot data. Future work will include a unique field-based flow manipulation of regulated rivers to monitor response of mussels to changing flows and sediment in their natural habitat, facilitated as a direct result of partnership with SSE, and also a novel experiment using PIT tagged mussels in their natural environment, in a variety of flow regimes (regulated, unregulated) to monitor behaviour over larger temporal and spatial scales. Present rates of M.margaritifera decline, combined with uncertain impacts of climate change, and the current and projected increase in hydroschemes which alter flow and sediment regimes and impact the passage of migratory host fish, suggest this research has a vital role in improving our understanding of physical and ecological requirements of this endangered species. Research findings will ultimately provide urgently needed empirical research that will drive future conservation strategies implemented by government (SNH, SEPA) and utilised by the hydroelectric industry (SSE).

Life cycle assessment of water consumption impacts from hydropower reservoirs on aquatic biodiversity

1. Martin Dorber 2. Kim Rainer Mattson 3. Roel May 4. Odd Terje Sandlund 5. Francesca Verones

Norwegian University of Science and Technology
Presenter: Mr Martin Dorber
Type of Presentation: ORAL

Abstract
Compared to conventional energy technologies, hydropower has much lower carbon emissions per kWh. Therefore, increasing hydropower contributes to mitigating climate change. However, at the same time, hydropower leads to other environmental impacts, affecting both aquatic and terrestrial biodiversity. Aquatic biodiversity in both reservoirs and streams, as well as riparian ecosystems, are affected by freshwater habitat alteration from storage and pumped storage plants. Damming to create reservoirs, storage and pumped storage plants reduces and alters downstream river discharge. In addition, the total volume of water available for downstream systems is reduced due to increased evaporation, as water surface area increases. The stored water in reservoirs allows a flexible electricity production, but alters freshwater habitats both in the reservoir and in the downstream rivers by changing the timing, magnitude, and frequency of the natural flow regime. To capture all of these impacts simultaneously requires holistic

assessments, including all relevant impact pathways of hydropower, to highlight the main environmental impacts and identify trade-offs between different energy production options and places of operation. Life cycle assessment (LCA) is a tool, which is particularly suited for identifying overall impacts and potential trade-offs between impacts within a product life cycle. However, LCA is still developing and does not yet cover impacts from hydropower production on freshwater biodiversity. Here we present a newly developed model for quantifying the amount of water consumption due to reservoir creation and corresponding impacts on aquatic biodiversity. This is the first model covering impacts on aquatic biodiversity from hydropower production in LCA. In a first step, we used the net water consumption approach in combination with the MODIS Global Evapotranspiration Project (MOD16)(1), to calculate water consumption per kWh produced in a global, reservoir specific approach. Additionally, an allocation factor is included to allocate water consumption of reservoirs with multiple purposes. For easier use in LCA studies, we derived also average values per watershed and country. For example, average water consumption for Norway is 0.013 m3/kWh. To quantify species loss per unit change of discharge, we used a Species-Discharge Relationship model, relating fish species richness (2) of each river catchment with the average annual discharge at the river mouth of that catchment. A power function explaining the relationship between the two variables is used to model the Potentially Disappeared Fraction of species (PDF) per m3 water consumed. To move from the calculated regional PDF we consider global extinction risk of fish with a newly developed Vulnerability Score for aquatic biodiversity. Average aquatic biodiversity loss from water consumption in Norway equates to 2.25e-9 PDF/m3. 1. Mu, Q.; Heinsch, F. A.; Zhao, M.; Running, S. W., Development of a global evapotranspiration algorithm based on MODIS and global meteorology data. Remote sensing of Environment 2007, 111, (4), 519-536. 2. GBIF (The Global Biodiversity Information Facility). Search occurrences. http://www.gbif.org/occurrence/search

Habitat suitability modelling of Pengba fish of Loktak Lake in Northeast India

R. Khosa, A. K. Gosain and A. K. Nema

Indian Institute of Technology Delhi
Presenter: Ms Khwairakpam Eliza
Type of Presentation: ORAL

Abstract

A number of anthropogenic stressors, including increasing pollutants in the catchment, construction of Hydroelectric project and Ithai barrage, over-exploitation and introduction of exotic species have caused habitat deterioration to Pengba fish of Loktak Lake in Northeast India. Pengba (Osteobrama belangiri) is the state fish of Manipur, native of Myanmar and regionally extinct in Manipur, listed under Near Threatened Species in IUCN Red List of Threatened Species. Before the

construction of barrage, this fish species used to migrate from Chindwin River of Myanmar to Loktak Lake, where they breed and grow. However, after the construction of barrage without fish ladder, the passage of this fish species have been blocked. Lake water biological oxygen demand (BOD), dissolved oxygen (DO) and temperature are important indicators of lake ecosystem health, which in turn, effecting habitat of Pengba fish. To properly manage affected system and achieve ecosystem sustainability, it is important to understand the relative impact of these factors. In this study, we predict relative impacts of stressors and model suitable habitat for Pengba fish using hydrodynamic (MIKE 21HD) and ecological model (MIKE 21 Eco Lab). The simulation results of ecological model suggest the requirement range of BOD, DO and Temperature for Pengba fish species. Results also suggest the hydrodynamic required in fish ladder for this fish species. This type of model offers a suitable measure of ecosystem services because it provides information about the requirement of this fish species under different conditions, which in turn help in eco-sustainability services of the lake.

Assessing the evidence of macroinvertebrate response to fine sediment in rivers

Morwenna Mckenzie Martin Wilkes Ian Foster Damian Lawler Judy England

Coventry University
Presenter: Miss Morwenna Mckenzie
Type of Presentation: ORAL

Abstract
Erosion, transportation and deposition of fine sediment (<2mm) are fundamental processes in the hydrogeomorphic cycle and river systems require a constant supply in order to function. However, excessive fine sediment delivery can cause serious deleterious effects to aquatic systems both in suspension and by deposition and is one of the leading causes for failure to meet Good Ecological Status as set out by the EU Water Framework Directive (2000/60/EC). Given the urgent need for effective management of fine sediment, by understanding which compartment of fine sediment that is driving macroinvertebrate response we can help inform biomonitoring practices better. There has been a number of review papers on the effects of fine sediment on aquatic ecology but thus far there have been no Systematic Reviews of the literature. First, we developed a conceptual model identifying the mechanistic pathways between fine sediment and macroinvertebrate community response. Then we used a method for Rapid Evidence Synthesis to examine these pathways to identify, based on existing literature, which compartment of fine sediment is causing the most significant effect on macroinvertebrates and to highlight any significant gaps in the literature. We found that there is a wealth of data regarding sediment associated contaminants (e.g. pesticides, metals) but a relative lack of evidence over other more direct mechanistic effects of fine sediment (e.g. abrasion, clogging) which have not been demonstrated at the organism level. We make recommendations to direct future research towards these mechanistic effects of fine sediment and the resulting effects

on community response. To assess macroinvertebrate community response to fine sediment on a wider scale, we collected data from 21 lowland sites across a multi-regional distribution. To minimise confounding factors, site selection was carried out using available data and filtered based on water quality, habitat modification, RIVPACS endgroup, and proximity to gauging stations (to provide hydrological data). At each site, we collected biological data using standard kicknet sampling and physical data of fine sediment using visual assessments and the resuspension/disturbance methodology. We used this data to compare the performance of two fine sediment biomonitoring indices which is the first time they have been independently verified. We found relative agreement of both sediment specific indices with gradients of fine sediment and make recommendations to improve these further.

Hydrological and thermal effects of hydropeaking on early life stages of salmonids: A modelling approach for implementing mitigation strategies

1. Roser Casas-Mulet 2. Knut T. Alfredsen 3. Svein J. Saltveit

The University of Melbourne / Water Research Institute, Cardiff University
Presenter: Roser Casas-Mulet
Type of Presentation: ORAL

Abstract
Alterations in hydrological and thermal regimes can potentially affect salmonid early life stages development and survival. The dewatering of salmon spawning redds due to hydropeaking can lead to mortality in early life stages, with higher impact on the alevins as they have lower tolerance to dewatering than the eggs. We present a set of modelling tools to assess the viability of implementing flow-related mitigation options in hydropeaking rivers, in order to minimise the risk of mortality in early life stages. We successfully modelled long-term (2002-2016) hydrological and thermal alterations in the River Lundesokna (Norway). We then assessed the consequences for early-life stages salmon development and the risk potential for egg and alevin mortality. We finally evaluated the cost-effectiveness of implementing three different release-related mitigation options (A: minimum flows release during early stages; B and C: additional reduction of flow during spawning). Overall, the economic cost of implementing mitigation measures was low and ranged between 0.7% and 2.6% of the annual hydropower production. Options B and C were considered more effective for egg and alevin survival, as reducing the flow during spawning would limit red creating below the mortality risk threshold. However, such options were constraint by water availability in the system for certain years, and therefore only option A was feasible all years. The set of modelling tools used in this study were satisfactory and provided expected results. The application of such modelling set can therefore be useful especially in systems where little field data is available. Targeted measures built on well-informed modelling tools can be tested on their effectiveness to mitigate dewatering effects vs. the hydropower system capacity to release or conserve water for power production. In additional, environmental flow releases targeting specific ecological

objectives can provide better cost-effective options than conventional operational rules complying with general legislation.

Natural or designer environmental flows for a changing world?

M Acreman

Centre for Ecology & Hydrology
Presenter: Prof Mike Acreman
Type of Presentation: ORAL

Abstract
Environmental flows are the quantities, quality and patterns of water flows required to sustain freshwater and estuarine ecosystems and the ecosystem services they provide for human well-being. There are many environmental flows methods, but most are based on either constraining alteration from a natural flow baseline to maintain biodiversity and ecological integrity or designing flow regimes to achieve specific ecological and ecosystem service outcomes. The former is more applicable to natural and semi-natural rivers where the primary objective and opportunity is ecological conservation. The latter suits modified and managed rivers where return to natural conditions is no longer feasible and the objective is to maximize natural capital, as well as support economic growth, recreation or cultural history; permitting elements of ecosystem design and adaptation to environmental change. Under a future with altered climate and heavy regulation, where hybrid and novel aquatic ecosystems predominate, the designer approach may become the only feasible option. This results from insufficient natural ecosystems from which to draw analogues and the need to support broader socio-economic benefits and valuable configurations of natural and social capital.

Benthic Biofilm Structure Alters Fine Particle Deposition and Resuspension in Streams

1-Kevin R Roche 2-Som Dutta, 2-Ketan Mittal 2-Paul Fischer 3-Jennifer D. Drummond 4-Fulvio Boano 5-Tom J. Battin 6-William R. Hunter 1-Aaron I. Packman

Northwestern University
Presenter: Kevin R Roche
Type of Presentation: ORAL
Abstract

Benthic (streambed) biofilms metabolize a substantial fraction of particulate organic matter and nutrient inputs to streams. These microbial communities comprise a significant proportion of overall biomass in headwater streams, and they present a primary control on the transformation and export of labile organic carbon. Biofilm growth has been linked to enhanced fine particle deposition and retention, a feedback that confers a distinct advantage for the acquisition and heterotrophic metabolism of particulate organic carbon.

We present experimental and numerical results that quantify the influence of biofilm structure on fine particle deposition and resuspension. Experiments were conducted in 12 stream mesocosms, where biofilms were grown over periods of 18-47 days to obtain a range of biofilm characteristics. Fluorescent, 8-μm particles were introduced to each flume, and their concentrations in the water column were monitored over a 30-minute period. We measured particle concentrations using a flow cytometer and mesoscale (10 μm to 1 cm) biofilm structure using optical coherence tomography (OCT). Particle deposition-resuspension dynamics were determined by fitting results to a stochastic mobile-immobile model, which showed that retention timescales for particles within the biofilm-covered streambeds followed a power-law residence time distribution. Particle retention times increased with biofilm areal coverage, biofilm roughness, and mean biofilm height. We conclude that biofilm structural parameters are key predictors of particle retention in streams and rivers, but observations are needed at finer spatial and temporal scales to quantify the influence of biofilm structure on particle deposition dynamics.

We explore these finer scales using novel numerical simulations, which fully resolve the turbulent flow field around the biofilm canopy on an impermeable streambed. OCT images from the experimental study were used to represent the biofilm topography, and Direct Numerical Simulation (DNS) of the flows were conducted at Reynolds number similar to the experiments. Simulations were conducted using Nek5000, an open-source, spectral element based solver for the incompressible Navier-Stokes equations. Our analysis shows that the biofilm topography alters the near-bed turbulence flow structure, compared with DNS of smooth channel flow at the same Reynolds number. Future DNS simulations will be extended to include inertial Lagrangian particles, allowing us to assess the impact of biofilms on fine particle fluxes at the sediment-water interface.

Conservation of native fish community: merging Ecohydraulics and Ecohydrology in the context of the Jucar River Basin District

F. Martinez-Capel (1) (invited speaker session S5) R. Muñoz-Mas (1) A.H. Ortín-Teruel (2) E.J. Olaya-Marín (3)

Universitat Politecnica de Valencia, Spain
Presenter: F. Martinez-Capel
Type of Presentation: ORAL

Abstract

Originally, the first methodological framework (IFIM) to study environmental flows (e-flows) provided a procedure to implement hydraulics, aquatic ecology, hydrology, water chemistry and institutional analyses in a decision-making process for water allocation. Later on in the 90's, the scientific community advocated new ecohydrologic approaches based on the natural flow regime, emphasizing the natural variability of the aquatic ecosystems. Nowadays, the coupling of both sciences (i.e., Ecohydrology and Ecohydraulics) is paramount in e-flow assessment

and aquatic ecosystems conservation, and several holistic e-flow methods provide useful research frameworks for these fields. However, the application of such methods is challenging because they require great understanding about the underlying processes governing population dynamics of aquatic and riparian biota to properly predict ecological responses to hydrological alteration. In the Jucar River basin (Eastern Iberian Peninsula), several habitat-based studies were performed at the microhabitat and the mesohabitat scales to relate summer low flows and the habitat suitability for the Jucar nase (Parachondrostoma arrigonis; Steindachner, 1866), a fish species critically endangered of extinction. However, the analyses of community response curves to flow alteration can give a wider perspective on e-flow assessment than those approaches focusing on individual species. Therefore, the ecological responses to hydrological alteration (in terms of magnitude and variability) for the family Cyprinidae, as well as for indicators of fish community composition were analysed based on data of 116 sites in the Júcar River Basin District. A conceptual ecohydrological scheme relating ciprinids life-history and flow regime was used to formulate hypotheses and to discuss the ecological responses. At the family level, different degrees (percentages) of negative alteration in the variability of winter flows (January) as well as positive alteration in mean and maximum summer flows showed relevant negative effects on ciprinids' total density. Furthermore, at the community level, similar variables for both winter and summer seasons indicated relevant reductions in native species richness and Shannon's index. These results highlight how ecohydrology and ecohydraulics complement one another, especially for none-sampled seasons and extreme hydrological conditions where the habitat-based approach lacked information in the basin. Nevertheless new challenges rose, such as the study of the effects of high (altered) summer flows on fish recruitment and the impacts of lower flow variability during wintertime. We concluded that the ecohydrological scheme for a fish community, the ecological responses observed and the seasonality of such responses are fundamental information in the assessment and implementation of e-flows, and should be considered in the context of a holistic approach. The extended application of either hydrological methods or habitat-based methods alone may, otherwise, leave the seasonality aside and produce simplified e-flows recommendations where the minimum flows or the high flows can be released at any time regardless the natural timing or the ecological responses of the aquatic assemblages.

Assessing the role of vertical flux on sediments ecology and community distribution in rivers: a holistic approach

Ignacio Peralta-Maraver, Jason Galloway, Malte Posselt, Shai Arnon, Julia Reiss, Jörg Lewandowski & Anne Robertson

University of Roehampton
Presenter: Ignacio Peralta-Maraver
Type of Presentation: ORAL

Abstract

We performed a holistic and interdisciplinary study at the interface of hydrology, ecology and biochemistry in order to address the hierarchical interplay between sediment hydrodynamics, community structure and biochemical processes of the hyporheic zone (HZ). We analysed the gradual variation in the community structure and biochemical composition between the benthic zone (BZ) and HZ at a high-resolution scale in both upwelling and downwelling zones. Our results showed that hydrology controls the vertical distribution of benthic and hyporheic communities. In up-welling zones the lower limit of the distribution of benthos occurred at deeper depths in the sediments than in downwelling zones. Additionally, biomass, production and diversity of organisms decreased with depth and biomass and production declined fastest under up-welling situations. However, the rate at which biomass and production decreased with depth differed significantly with taxonomic group. Finally, it was not possible to associate the attenuation of nutrients and pollutants with the ecological features of the community or the hydrology. However, the majority of these compounds decreased faster along the upper sediment layers, where communities were more diverse and productive.

Understanding and predicting juvenile salmon abundance at large spatial scales using landscape proxies for habitat.

1. Iain A. Malcolm 1. Karen J. Millidine 1. Ross S. Glover 1.2. Colin P. Millar 3. Robert J. Fryer

Marine Scotland Science Freshwater Fisheries Laboratory
Presenter: Iain Malcolm
Type of Presentation: ORAL
Abstract
Models that predict spatio-temporal variability in juvenile salmonid abundance are required to assess the status of fish populations and to understand the effects of anthropogenic impacts. Unfortunately many fish habitat models require intensive field based data collection that precludes their use at larger spatial scales appropriate to fisheries and catchment management. Furthermore, some of the habitat factors that influence fish abundance also affect their capture probability, confounding interpretation of available monitoring data. Delivering solutions to these two challenges is therefore critical in the development of fish abundance models that can be used for large scale fisheries management and assessment. Salmon densities vary in response to a wide range of biotic (spawner numbers, food availability, competition, predation) and abiotic (water chemistry, river temperature and physical habitat) factors which are not easily characterised. However, large scale spatial variability in habitat can be characterised through analysis of spatial datasets such as Digital Terrain Models or landuse maps thereby providing habitat proxies. This paper presents an approach for understanding and predicting juvenile salmonid densities at a national (Scotland) scale, using a diverse electrofishing dataset corrected for spatio-temporal biases in capture probability. Multi-pass electrofishing data was collated from fisheries trusts, fisheries boards, SEPA and Marine Scotland. Covariates describing spatial, temporal and habitat variability were obtained for each sampling event. A two stage likelihood based

mixed modelling approach was developed. Firstly, capture probability was modelled in relation to covariates. Secondly, densities were modelled in relation to covariates, conditional on estimated capture probabilities. Capture probability was related to explanatory variables indicative of equipment, personnel and protocols, fish size, fish behaviour, habitat, and time. Salmon densities varied with lifestage, habitat proxies (distance to sea, altitude, riparian landuse and upstream catchment area) and region (hydrometric area). The resulting models can underpin approaches for assessing the status of fish populations at large spatial scales. Future development of the models could improve understanding and prediction of fish abundance by incorporating additional metrics of habitat quality (e.g. river temperature and water quality). The approach also has the potential to improve understanding of anthropogenic impacts by incorporation metrics of habitat alteration (e.g. hydrological change).

Combined effects of climate change and dam construction on riverine ecosystems

1. Mijke van Oorschot (1,2) 2. Maarten Kleinhans (1) 3. Tom Buijse (2) 4. Gertjan Geerling (2,3) 5. Hans Middelkoop (1)

Deltares
Presenter: Mrs Mijke van Oorschot
Type of Presentation: ORAL

Abstract
For a long time humans have been altering river systems by constructing dams to fulfill their water needs and for protection against floods. On top of that climate change is expected to affect the hydrological regime by increasing extreme events and shifting flow seasonality. Riparian vegetation interacts mutually with river hydrodynamics and morphodynamics and have adapted many of their life-history processes to the typical flood regime. Flow alteration will therefore inevitably lead to changes in vegetation distribution patterns by affecting vegetation settlement, survival and their interactions with hydro-morphodynamic processes. Vegetation as well as river morphology adapt to new discharge conditions which makes it a challenge to distinguish long-term effects of the natural discharge variation from effects of climate change and dams. Therefore, the aim of this study is to compare natural with altered flow regimes with individual as well as combined effects of dams and climate change on river morphology, riparian vegetation, aquatic vegetation and fish. This is done with an advanced numerical model containing dynamic interactions between morphodynamic processes and vegetation, allowing us to investigate these complex and dynamic interactions on the scale of several decades. We ran two scenarios with different dam operating regimes; both with flow stabilization, and one with added reversed flow seasonality. We also ran two scenarios with climate change; one with increasing extreme events in low and high flows and one with a drying trend. We further ran all combinations of dams and

climate change and a control with an unaltered, natural flow regime. We find large and different effects of flow alteration regimes on river morphology and riparian vegetation. Generally, changes are more drastic and acute in case of dam construction compared to climate change. Imposed shifts in flow seasonality strongly reduces settling of riparian species and causes the largest deviation in habitat suitability of riverine species compared to the natural flow regime. Flow stabilization by dams reduces morphological activity and rejuvenation, leading to aging of riparian vegetation and advancement of terrestrial species. On the other hand, climate change with extreme events leads to increased rejuvenation of riparian vegetation. We see that habitat suitability of a range of riverine species is tightly linked to periodicity of channel dynamics and is dictated by variability in river hydro-morphodynamics combined with timing of important life-history processes of these species. For instance, the reversed flow regime creates beneficial conditions for wetland species because it provides sufficient water during late spring and summer, when water is usually most limited. On the other hand, spawning of Salmon and Pike are negatively affected because there is less water during spawning in winter, for Salmon and early spring, for Pike. Combinations of climate change and dams show that inferred discharge trends cannot simply be extrapolated to morphodynamic behavior and related vegetation patterns. Rather, our result show complex and non-linear behavior in river morphology and ecology with multiple adaptation timescales. This suggests that long-term process-based models are imperative in further unraveling biogeomorphological effects of flow alteration.

S5 Linking hydroecology and ecohydraulics: towards a better understanding of interactions between ecosystems, hydraulics and hydrological processes

Valérie Ouellet, Stephen Dugdale

Conservation of native fish community: merging Ecohydraulics and Ecohydrology in the context of the Jucar River Basin District

F. Martinez-Capel (1) (invited speaker session S5) R. Muñoz-Mas (1) A.H. Ortín-Teruel (2) E.J. Olaya-Marín (3)

Universitat Politecnica de Valencia, Spain
Presenter: F. Martinez-Capel
Type of Presentation: ORAL

Abstract

Originally, the first methodological framework (IFIM) to study environmental flows (e-flows) provided a procedure to implement hydraulics, aquatic ecology, hydrology, water chemistry and institutional analyses in a decision-making process for water allocation. Later on in the 90's, the scientific community advocated new ecohydrologic approaches based on the natural flow regime, emphasizing the natural variability of the aquatic ecosystems. Nowadays, the coupling of both sciences (i.e., Ecohydrology and Ecohydraulics) is paramount in e-flow assessment and aquatic ecosystems conservation, and several holistic e-flow methods provide useful research frameworks for these fields. However, the application of such methods is challenging because they require great understanding about the underlying processes governing population dynamics of aquatic and riparian biota to properly predict ecological responses to hydrological alteration. In the Jucar River basin (Eastern Iberian Peninsula), several habitat-based studies were performed at the microhabitat and the mesohabitat scales to relate summer low flows and the habitat suitability for the Jucar nase (Parachondrostoma arrigonis; Steindachner, 1866), a fish species critically endangered of extinction. However, the analyses of community response curves to flow alteration can give a wider perspective on e-flow assessment than those approaches focusing on individual species. Therefore, the ecological responses to hydrological alteration (in terms of magnitude and variability) for the family Cyprinidae, as well as for indicators of fish community composition were analysed based on data of 116 sites in the Júcar River Basin District. A conceptual ecohydrological scheme relating ciprinids life-history and flow regime was used to formulate hypotheses and to discuss the ecological responses. At the family level, different degrees (percentages) of negative alteration in the variability of winter flows (January) as well as positive alteration in mean and maximum summer flows showed relevant negative effects on ciprinids' total density. Furthermore, at the community level, similar variables for both winter and summer seasons indicated relevant reductions in native species richness and Shannon's index. These results highlight how ecohydrology and ecohydraulics complement one another, especially for none-sampled seasons and extreme hydrological conditions where the habitat-based approach lacked information in the

basin. Nevertheless new challenges rose, such as the study of the effects of high (altered) summer flows on fish recruitment and the impacts of lower flow variability during wintertime. We concluded that the ecohydrological scheme for a fish community, the ecological responses observed and the seasonality of such responses are fundamental information in the assessment and implementation of e-flows, and should be considered in the context of a holistic approach. The extended application of either hydrological methods or habitat-based methods alone may, otherwise, leave the seasonality aside and produce simplified e-flows recommendations where the minimum flows or the high flows can be released at any time regardless the natural timing or the ecological responses of the aquatic assemblages.

Geomorphological variables to predict spatial distribution of plant species in agricultural ditches

Gabrielle RUDI, Jean-Stéphane BAILLY and Fabrice VINATIER

SupAgro / INRA - FRANCE
Presenter: Gabrielle RUDI
Type of Presentation: ORAL

Abstract
Background : In Mediterranean cultivated lands, exogenous variables controlling spatial distribution of non-cropped plant species at the landscape scale are habitat variables, seed-sources proximity, and lastly human practices. In order to manage ecosystem services provided by head catchments drainage networks (ditch networks), we need to predict spatial distribution of plant species living in them. Geomorphological variables have shown to be important habitat variables in other ecosystems (riverine, wetlands,...), but whether such variables can be used to predict plant distribution in ditch networks is unknown. An arising question is then : which is the importance of geomorphological variables for explaining plant species distribution at the ditch network scale ? Methodology : We collected presence and absence data for 10 plant species (herbaceous) on a 35-km ditch network in a Mediterranean cultivated land. We simulated their spatial distribution using geomorphological and land-use derivative variables (representative of seed-sources proximity) with Maxent and GLM model. Each plant species was considered separately and each model was validated using k-fold cross-validation (k=4). We compared mean AUC (Area Under the Curve) values obtained for each model and relative importance of explanatory variables. We analysed compiled false positive and false negative residual maps. Results : Mean AUC values for Maxent model ranged from 0.92 for Mentha aquatica to 0.67 for Rubus fruticosus. Mean AUC values for GLM ranged from ranged from 0.86 for Lythrum salicaria to 0.61 for Rubus fruticosus and Sorghum halepense. Both geomorphological and land-use derivative variables were important to explain Asparagus acutifolius, Equisetum arvense, Mentha aquatica, Mentha suaveolens, Rumex crispus, Scirpus holoschoenus distribution and only geomorphological variables well explained Lythrum salicaria

distribution. The models failed to explain accurately Sorghum halepense, Rubus fruticosus and Elytrigia juncea distribution. Compiled residual maps showed a false positive predictions pattern at the South of the catchment. Conclusion : We highlighted the importance of considering geomorphological variables to explain spatial distribution of plant species in Mediterranean head catchments drainage ditches. Results suggested that part of the remaining non-explained variability for some species was induced by human practices. Agro-ecological measures aiming at managing ecosystem services provided by ditch networks have to consider plant specific predictors at the local and landscape scale in order to be successful. They further have to investigate human practices effects on ditch plant distribution.

The Ecohydraulics of Dam Renewal

Katy Haralampides Mouhamed Ndong Gordon Yamazaki Allen Curry Tommi Linnansaari Bernhard Wegscheider

University of New Brunswick
Presenter: Ms Katy Haralampides
Type of Presentation: ORAL

Abstract
The Mactaquac Aquatic Ecosystem Study (MAES) is a planned, whole-river ecosystem study and manipulation of the Mactaquac Generating Station (MGS), a 672 MW run-of-the-river hydroelectric facility on the main stem of the Saint John River, New Brunswick, Canada. The Canadian Rivers Institute is undertaking MAES in support of a decision making process regarding the future of the MGS by its owner, New Brunswick Power. Future options under consideration ranged from in-situ restoration to full removal and river restoration. With a catchment area of 55,000 km2 and overall length of 618 km, the Saint John River is one of the largest river systems on the eastern seaboard of North America. The MGS renewal project, regardless of selected option, will be the largest ever undertaken in the world. For these reasons, MAES was designed to advance the science of dam renewal projects using a holistic, multidisciplinary approach. In support of primary research objectives about the predicted hydrodynamic regime and associated sediment transport due to potential upstream modifications to the dam, a computational model was developed using the Delft3d software suite. The model was set up in two dimensions using rectangular grid elements starting upstream of the MGS, and extending approximately 200 km to just above the Port of Saint John where the river enters the Bay of Fundy. Integrating the findings from MAES bathymetric and substrate surveys, predicted depth-averaged water surface elevations and velocities, as well as associated sediment dynamics were calculated under various hydroclimatic and seasonal flow conditions. The secondary objective of the 2d model is to support ecosystem studies linking biotic and abiotic components in an ecohydraulics context. The use of fuzzy logic based habitat simulation software (Casimer) is explored in critical inter-island habitats. Sediment transport simulations are used to predict the long-term effects of sediment retention in headponds on downstream sediment-dependent wetlands. Simulations will also be

run to complement the fish passage studies, giving estimates of velocity distributions and water levels. Working on such a large, actively regulated river system that includes substantial seasonal flow differences, a tidal range that exceeds 7m at the mouth, a limited fieldwork sampling window because of the Canadian winter, and varied water depths from very shallow island habitat to a deep lake-like headpond has presented challenges in data collection. Multiple technologies have been required for collection of bathymetry, flows, sediment and other water quality parameters needed for calibration and verification of the models. Our 'lessons learned' list is growing. We will be collecting more verification data for our ecohydraulics studies throughout the summer and fall of 2017, and will be furthering and refining our predictive models. Our results to date have informed the NB Power MGS decision-making process, have identified areas of interest/concern, and have helped to advise future data and study requirements. Ultimately, we believe that the MAES approach will be useful as a basis for other dam renewal projects around the world.

Will climate-related changes in runoff be an enhancement or impairment for riparian vegetation?

Dagmar Kappel Andersen Annette Baattrup-Pedersen

Aarhus University
Presenter: Dr Dagmar Kappel Andersen
Type of Presentation: ORAL

Abstract
Will climate-related changes in runoff be an enhancement or impairment for riparian vegetation? Riparian areas of the temperate zone naturally host a diverse range of habitats with a high conservation value, high species richness and a large share of rare and endangered species. Riparian areas, however, also constitute one of the most threatened habitats due to eutrophication, hydrological alterations and fragmentation. A long tradition of river engineering involving, for instance, channel re-sectioning and straightening, has disturbed natural flooding regimes and the ensuing sediment deposition, which have led to significant shifts in species composition and loss of valuable habitats in the associated river valleys. For example groundwater-dependent vegetation types such as fens and wet meadows, are highly sensitive to altered disturbance regimes in streams and rivers, which may relate to both interference with the groundwater characteristics of the areas and to altered disturbance regimes. In a future climate, more heavy precipitation events are expected, which will likely result in more frequent and prolonged floods. This may impact previously unflooded areas and affect the vegetation in several ways. Frequent and prolonged floods may increase the availability of nutrients as the availability is generally high in the flood water as well as in the deposited sediments. The deposition of sediments may be especially important since nutrients may be released slowly over months or years and therefore mediate a continued supply of nutrients that may influence species dominance patterns through altered competitive interactions. Thus, high nutrient levels promote highly competitive

species at the expense of weak competitors. On the other hand, intensification of disturbance may weaken the competitive species leaving space for more stress-tolerant species. In the present talk, I will present results of an extensive long-term experimental study conducted to explore effects of flooding and sediment deposition on protected groundwater-dependent vegetation types in a Danish riparian wetland. Under controlled conditions we mimicked a natural flooding event by pumping stream water into areas with fen-meadow communities with contrasting conservation status (relatively low-productive fen/fen-meadow community and high-productive, degraded fen community). Following flooding, stream sediments were deposited within the areas. The sediment originated from a natural floodplain and was enriched with seeds of five target species to ensure that seeds of such species would be present, which allowed us to evaluate also the establishment and survival potential of target species in flooded areas.

Quantifying the effects of compensation flow releases from impoundments on riverine ecosystems

Henk Krajenbrink (1) Paul Wood (1) Mike Acreman (2) David Hannah (3)

Loughborough University
Presenter: Henk Krajenbrink
Type of Presentation: ORAL

Abstract

River impoundment by the construction of dams and creation of reservoirs is considered one of the most significant and spatially extensive anthropogenic impacts on river ecosystems globally. It has the potential to change and modify a range of abiotic and biotic factors, including channel morphology upstream and downstream of the structure, discharge regime, water quality characteristics and instream ecology. Modification of the natural flow regime of a river is widely regarded as the most important factor influencing instream ecology (community structure and composition) and ecosystem processes. The last decades have seen a growing body of research centred on the impact of river impoundment and the identification of appropriate 'environmental flows', with a focus on mitigating and managing the effects of large hydropower dams on downstream aquatic ecosystems. In the UK, an estimated 600 large dams (higher than 15 m) and numerous smaller structures exist, primarily for water supply purposes. The majority of dams operate compensation flow release schemes, often with fixed minimum flow releases. Growing concern regarding the effects of relatively stable compensation flows on aquatic ecosystems has led to the establishment of monitoring schemes on heavily modified waterbodies associated with the implementation of the EU Water Framework Directive. This paper presents the results of an England-wide comparison of paired unregulated (control) and regulated (impacted) sites associated with impoundments subject to compensation flow release schemes using multi-year macroinvertebrate community data. Biomonitoring data has been analysed in conjunction with environmental variables including discharge and water quality with an explicit focus on identifying the effects of flow regime

modification. Results indicate that macroinvertebrate communities at regulated sites differ from those at paired unregulated sites, both in species richness and community structure. Species richness is typically higher at impacted sites than at unregulated control sites. The research will improve our understanding of the long-term effects of compensation flow releases on instream communities and will provide a basis for future implementation of mitigation measures and the quantification of environmental flows on impounded heavily modified waterbodies. (preferred session S4 "Environmental Flows – Quantifying interactions between hydrological and biological processes")

Fuzzy fish habitat modelling for the assessment of environmental flow needs.

Julien Mocq, Valerie Ouellet

INRS-ETE

Presenter: André St-Hilaire

Type of Presentation: POSTER

Abstract

The substitution of a natural flow by a managed flow regime can lead to fish habitat loss, higher (e.g. by hydropeaking) or lower (e.g. by reservoir filling) discharge variations, decrease of wetted area and flow velocity, and an increase of temperature and dissolved oxygen variations. Many tools exist, based on hydrology, geomorphology or biology to estimate environmental flows. Among these tools, habitat preference models are known to be relatively sophisticated methods to evaluate Environmental flow by integrating hydraulics, hydrology and ecological factors such as species' preferences for a certain range of abiotic conditions in the river. This is most often done through the development of curves of Weigthed Usable Area of habitat as a function of discharge for a given species or guild. Unfortunately, the models and curves are often used in stream-specific applications and are rarely easily exportable. With the aim to address this shortcoming, we developed several habitat suitability indices sets for three Atlantic salmon (Salmo salar) life stages (young-of-the-year (YOY), parr, spawning adults) with the help of fuzzy logic modeling. Using the knowledge of twenty-seven experts, from both sides of the Atlantic Ocean, we defined fuzzy sets of four variables (depth, substrate size, velocity and Habitat Suitability Index, or HSI) and associated fuzzy rules. When applied to the Romaine River (Canada), median curves of standardized Weighted Usable Area (WUA) were calculated and a confidence interval was obtained by bootstrap resampling. The impact of the origin of the experts on their assessment of habitat suitability was investigated. A similar fuzzy model was subsequently developed on a larger system, the St.Lawrence River, and included water temperature as an additional habitat variable. Work is currently underway to include water temperature in the salmon habitat model.

S6 Novel approaches in plant, soil, water atmosphere interactions
Josie Geris

Improved monitoring strategies for understanding greenhouse gas emissions from variable saturated landscapes

Trenton E. Franz Terrance D. Loecke Amy J. Burgin

University of Nebraska-Lincoln
Presenter: Prof Trenton Franz
Type of Presentation: ORAL

Abstract
Understanding greenhouse gas (GHG) fluxes from landscapes with variable saturated soil conditions is challenging given the highly variable nature of GHG fluxes in both space and time, dubbed hot spots and hot moments. On one hand, our ability to directly monitor these processes is limited by sparse in-situ and surface observational networks. On the other hand, proximal and remote sensing observations provide spatial datasets but are limited by indirect observations and infrequent repeat mapping in time. In this work, we present a robust statistical framework to merge sparse sensor network observations with reconnaissance style hydrogeophysical mapping at a well studied study site in Ohio, USA. Specifically, we combine time-lapse hydrogeophysical surveys with landscape features to generate statistical models of: 1) soil inventories (i.e. clay percent, soil carbon, and soil nitrogen) across the study site and 2) spatiotemporal models of key abiotic factors (i.e. soil temperature, soil water content, and soil oxygen) that affect GHG fluxes. The framework uses the well established technique of Empirical Orthogonal Functions, which allows for temporal gap filling of individual sensor data as well provides flexible geometric interpolation to complex areas/volumes. We anticipate the framework, with its flexible temporal and spatial monitoring options, will be well suited for use in the next generation of hyper-resolution hydrologic and biogeochemical models.

Soil-plant-water interactions at the Sunjia Red Soil Critical Zone Observatory: implications for water and nutrient dynamics

Geris, J (1), Verrot, L (1), Oyesiku-Blakemore J (2), Gao, L (1,3), Peng, X (3), Hodson, ME (4), Zhang, G (3), Smith, JU (2), Hallett, PD (2)

School of Geosciences, University of Aberdeen
Presenter: Josie Geris
Type of Presentation: ORAL

Abstract
Ecosystems in most intensively managed agricultural environments are incredibly vulnerable to environmental change. About 40% of China's agriculture is provided by the intensive management of 20% of its land area covered with vulnerable, highly weathered Red Soils. More efficient use of water and fertilisers in this region

is essential to ensure agricultural sustainability for appropriate crops. In this context, we aim to gain a better understanding of plant-soil-water interactions and how these affect water and nutrient cycling at a range of scales, using data-sets that go back almost 15 years. More specifically, we focus on the Red Soils Critical Zone Observatory (CZO) in subtropical southeastern China and explore (i) the control of root-zone soil physical and biogeochemical changes on water and carbon cycling for a range of representative rain-fed crop types (including peanut, citrus, and mixed fruit trees), (ii) how temporal variations in these interactions are affected over different time scales ranging from daily, seasonal to multiannual, and (iii) how the resulting time-variable spatial patterns aggregate to generate catchment scale water and carbon fluxes in mixed land use areas with rain-fed crops and irrigated rice paddy fields. The approach involves coupled hydrological and nutrient cycling models, informed by field experiments and long-term CZO monitoring of the key quantity and quality parameters of soil, vegetation and water. We found that the integrated hydrological and nutrient cycling models improved both model performance and our understanding of the soil-vegetation interactions on water and carbon fluxes, as opposed to using separate approaches. Preliminary results demonstrate that both the magnitude and timing of vegetation impacts are crop dependent at different time scales (at least seasonally and annually). As such, their relative contribution to catchment scale fluxes is time-variable, which may lead to different management implications. However, at the catchment scale paddy irrigation impacts dominate the nature of water and nutrient fluxes. Future work will focus on testing alternative approaches to water and land management (e.g. in irrigation practices, land use, and application of fertilizers) and determining the sensitivity of these ecosystems to climate change.

Ecohydrological response of apple trees in the Eastern Italian Alps: Water isotopic composition of xylem sap, soil water and groundwater due to rainfall and irrigation events

Jay Frentress, (1) Michael Engel, (1) Daniele Penna, (2) Francesca Scandellari, (1) Massimo Tagliavini, (1) Damiano Zanotelli, (1) Francesco Comiti, (1)

Free Univerity of Bolzano
Presenter: Jay Frentress
Type of Presentation: ORAL

Abstract
Recently, ecohydrological investigations between trees and the other water cycle components have benefitted from the use of stable isotopes of water. However, few experiments so far have been conducted in agricultural settings and our understanding of fluxes and apportionment of water between rainfall, soil, groundwater and within plants is still limited. Here we seek to trace water fluxes through apple trees in an alpine valley using a combination of natural and artificial rainfall sources to quantify the extent of mixing between sources and determine water sources used by trees. We query how depth to groundwater affects fluxes

between ecohydrological compartments as well as the isotopic composition of transpired water relative to atmospheric inputs and subsurface water sources. We monitored sapflow, soil moisture, groundwater and rainfall in an apple orchard (Malus domestica) located in South Tyrol, northern Italy. 20-mm irrigation inputs, typically isotopically distinct from natural rainfall, were applied weekly at the site. Two neighboring sites were selected for their different groundwater levels and stream proximity. Xylem sap, soil water, groundwater, and irrigated and natural rainfall sources were sampled at monthly intervals over two years and isotopic composition determined by laser spectroscopy and isotope ratio mass spectrometry (in the case of xylem water). We found that the isotopic composition of xylem sap was distinct from irrigation water and similar though enriched relative to soil water. Xylem sap fell below the local meteoric water line, ranging from -55 to -72 2H ‰ and -4 to -9 18O ‰, and appeared largely derived from soil water from the upper 40 cm. Mean isotopic composition of groundwater and irrigation water were quite similar, -103 2H and -14 18O ‰ for groundwater and -100 2H and -14 18O ‰ for irrigation water. Mobile soil water isotopic composition was variable though enriched relative to irrigation water sources, suggesting evaporative enrichment within the soil profile, particularly at shallow depths. In the orchard where the groundwater table was 120 cm below the surface, near surface (0 - 10 cm) soil water deuterium concentrations were greater than in the orchard where the groundwater table was 50 cm below the surface (-42 vs -65 2H ‰, respectively). Overall, while sapflow sources appeared to be mainly derived from the shallow soil layers, the soil isotopic composition was related to the depth to groundwater, with soil water isotopic composition at the shallow groundwater orchard exhibiting less enrichment than the orchard overlying a deeper groundwater table. These findings highlight the complex controls on the variability of isotopic composition in agricultural ecohydrological compartments and suggest that plant-focused ecohydrology studies should continue to better assess the factors determining changes in isotopic composition and the groundwater-soil-transpiration interactions.

The effect of artificial changes on the intensive macrophyte growth in the river channel

Takashi Asaeda, Chandani Chalanika, Md Harun Rashid, Abner Barnuevo, Lekkala Vamsi Krishna

Saitama University
Presenter: Prof Takashi Asaeda
Type of Presentation: ORAL

Abstract

Macrophytes often grow intensively and densely cover the river channel. In some of western Japanese rivers, Go River, Saba River, etc. macrophytes, mainly Egeria densa, grew profusely and established river-wide dense colony in the past decade. Since they accumulate fine sediments and create an anoxic sediment layer on the river bed, water quality deteriorated and inland fisheries suffered decline. Field

observations were conducted at twenty sites in Eno River, a main tributary of Go River, Saba River, and some tributaries of Hii River in June while the plants were growing, and in September while the plants were at pre-senescence stage. The longitudinal distribution of colonies at each river was observed along the river channel with respect to the bottom condition of the channel, and artificial structures as well as velocities. A 30-minute dark condition was created by setting a black patch over macrophyte colonies at each site. Shoots of E. densa were collected from a colony in light condition (before setting the patch), and immediately after the dark treatment. The shoots were packed in a freezing box for chemical analyses, and biomass was harvested from a 1m × 1m quadrat set in the colony. Velocity was measured with ultrasonic current meter at two depths, and depth-wise radiation intensity was obtained. In the laboratory, one of reactive oxygen species, H2O2, antioxidant enzymes, and chlorophyll and carotenoid concentrations of the plant tissues were analyzed to understand the levels of environmental stresses at each site. Generally dense macrophyte colonies were observed at the stagnant water in the upstream of weirs, and nearly no growth was observed in riffles, compared to high biomass in pools. H2O2 concentration linearly increased with increasing turbulence intensity rather than mean velocity (Figure). The chlorophyll concentration linearly decreases with the increasing H2O2 concetration. Antioxidant activity increased proportionally with H2O2 concentration, while the total biomass had a proportional increasing trend with chlorophyll concetration. The comparison of the fractions of H2O2 concentration due to light and velotity stresses suggested the oxidative stress by turbulence in the flow was in the higher level than that of light. Then, it was found that the reduction of turbulnce in the flow was the main reason of the intensive growth of E.densa. These results indicate that the dense colony of E.densa is established attributed to the frequent construction of weirs in the channel, and the reduction of gravel sediments on the channle bed by sediment mining in the last three decades and the weir constructions.

Assessing efficiency and impediments of root water uptake using thermodynamics

Anke Hildebrandt 1,2 Marcel Bechmann 1,2 Axel Kleidon 2 Thomas Kalbacher 3

University of Jena
Presenter: Anke Hildebrandt
Type of Presentation: Oral

Abstract
Much of the primary productivity of terrestrial ecosystems depends on the capacity of plants to access water. A great deal of research has been dedicated to plant water relations, root water uptake and water stress, both using models and observations. Much of the process-based research on root water uptake is related to identifying which process impedes transpiration, and generally, whether this occurs inside or outside of the plant's vascular system. Addressing this question requires the upscaling and combination of a large number of complex processes, which is challenging in part due to heterogeneous soil water conditions and diverse plant

hydraulic architectures. Here, we take a new look at root water uptake. As water flows from the soil to the root and transpires into the atmosphere, it follows potential gradients and dissipate associated forms of energy. Thermodynamics allows us to quantify this dissipation. It provides a tool for scaling up the consequences of small-scale processes in terms of their effects on dissipation, changes of internal energy, and total energy export from the soil-plant system. By quantifying how different processes each contribute to these energetic terms we can characterize how effective root water uptake takes place in terms of how dissipative losses are reduced. Being able to disintegrate the contribution of different flow paths in these energetic terms allows us to understand which process impedes water uptake most strongly. We apply the thermodynamic diagnostic to a three dimensional root water uptake model in order to investigate how distribution of root traits (hydraulic conductivity) affects the efficiency of root water uptake in isolated plants that are not affected by competition. Root trait distribution was varied while the overall root architecture was kept equal in all simulations. Results show that efficiency of root water uptake is only compromised in extreme and unrealistic cases, where root systems are composed of either only fine roots or suberized transport roots. With more realistic assumptions, root water uptake was predominantly impeded by abiotic factors (outside of the plant), particularly dissipation induced by bulk water flow towards the plant's root system. The latter was much enhanced in fine-textured soils, causing early limitation of transpiration. The second impeding process that can be identified was the radial flow paths within the root, closely followed by microscopic radial flow towards the root (coarse soil textures only) and and the heterogeneity of soil water distribution (fine soil textures only). Our results show that diagnosing soil water flow from the soil to the atmosphere in the energy domain provides novel process insights, which improve our understanding of efficient root systems. The thermodynamic diagnosis is very general and not limited to root water uptake, and may be extended to provide novel insights of hydrologic processes in general.

Low flow controls on stream micro-thermal dynamics

Silvia Folegot[1], David M. Hannah[1], Stephen J. Dugdale[1], Marie J. Kurz[2], Jen Drummond[3], Megan J. Klaar[1,4], Joseph Lee-Cullin[5], Toralf Keller[2], Eugènia Martí[3], Jay P. Zarnetske[5], Adam S. Ward[6] and Stefan Krause[1]

[1]School of Geography, Earth and Environmental Sciences, University of Birmingham, Edgbaston, Birmingham, B15 2TT U.K.
[2]Department of Hydrogeology, Helmholtz Centre for Environmental Research-UFZ, Leipzig, Germany
[3]Centre for Advanced Studies of Blanes (CEAB-CSIC), Blanes, Girona, Spain
[4]School of Geography, University of Leeds, LS2 9JT Leeds, U.K.
[5]Department of Earth and Environmental Sciences, Michigan State University, East Lansing, Michigan, USA
[6]School of Public and Environmental Affairs, Indiana University, Bloomington, Indiana, USA

Correspondence to: Silvia Folegot (SXF356@student.bham.ac.uk)
Presenter: Silvia Folegot
Type of Presentation: Oral

Water level fluctuations in surface water bodies, and in particular low flow drought conditions, are expected to become more frequent and more severe in the future due to the impacts of global environmental change. Variations in water level, and therefore in-channel water volume, not only have the potential to directly impact stream temperature, but also aquatic vegetation coverage which, in turn, may affect stream temperature patterns and dynamics. Manipulation experiments provide a systematic approach to investigate the multiple environmental controls on stream temperature patterns. This study aims to use temperature data loggers and fibre optic distributed temperature sensing (FO-DTS) to investigate potential drought impacts on patterns in surface water and streambed temperature as a function of change in water column depth. To quantify the joint impacts of water level and associated vegetation coverage on stream temperatures, investigations were conducted in outdoor flumes using identical pool-riffle-pool features, but with spatially variable water levels representative of different drought severity conditions. Naturally evolved vegetation growth in the flumes ranged from sparse vegetation coverage in the shallow flumes to dense colonization in the deepest. Observed surface water and streambed temperature patterns differed significantly within the range of water levels and degrees of vegetation coverage studied. Streambed temperature patterns were more pronounced in the shallowest flume, with minimum and maximum temperature values and diurnal temperature variation being more intensively affected by variation in meteorological conditions than daily average temperatures. Spatial patterns in streambed temperature correlated strongly with morphologic features in all flumes, with riffles coinciding with the highest temperatures, and pools representing areas with the lowest temperatures. In particular, the shallowest flume (comprising multiple exposed features) exhibited a maximum upstream-downstream temperature warming of 3.3 °C (T in = 10.3 °C, T out = 13.5 °C), exceeding the warming observed in the deeper flumes by ~ 2 °C. Our study reveals significant streambed and water temperature variation caused by the combined impacts of water level and related vegetation coverage. These results highlight the importance of maintaining minimum water levels in lowland rivers during droughts for buffering the impacts of atmospheric forcing on both river and streambed water temperatures.

S7 Ecohydrology in restoration practice - ecosystem management, engineering and society

Bob Grabowski

Rivers and restoration practise in Portugal: a brief journey through past, present and the future

Samantha Jane Hughes* ** João Cabral* Edna Cabecinha* Rui Cortes** Mario Santos*

University of Trás-os-Montes e Alto Douro - Centre for Research & Technology in Agro-Environment & Biological Sciences
Presenter: Samantha Jane Hughes
Type of Presentation: ORAL

Abstract

We present a general overview of the knowledge and state of Portugal's rivers together with selected examples of river restoration initiatives and practise in Portugal. We cover the requirements of the Water Framework Directive and compensatory measures that involve river restoration measures as a result of the construction of large grey infrastructures, namely dams. We also present information on collaboration in river restoration projects or projects to improve citizen participation and knowledge with stakeholders such as municipal councils and national NGO's. Modelling methods are essential "tools" in predicting the possible outcome of different types and scales of impacts such as land use change or interventions such as restoration measures on the ecological status of rivers or the response of target species. We present findings on different modelling methods applied in Portugal: from River 2D to support studies on the habitat preferences of endemic fish species to an outline of the Stochastic Dynamic Methodology (StDM) and its potential role in aquatic resource management, including river restoration measures. This sequential modelling process has been applied to assess scenarios of change across a range of altered ecosystems, can embrace system complexity and stochasticity (e.g. flood or wildfire events) in scenario development and integrate different types of explanatory data and target indicators. to identify the best management procedures, the most suitable indicators of restoration measures and how combinations of measures can benefit target species or specific objectives, such as such as improved WFD status of waterbodies. We show how uncertainty is still a major factor to consider in modelling and how unforeseen circumstances can influence the success or failure of restoration measures. Finally, we present some suggestions on the future of river restoration in Portugal.

Incorporating hydroecology in strategic water resources investigations

Johanna Withington

Atkins Ltd
Presenter: Stuart Smith
Type of Presentation: ORAL

Abstract
The Water Resources East (WRE) vision is to provide an integrated long-term water management strategy, prepared through multi-sector collaboration and planning, that takes account of the needs of all of those in the WRE region with an interest in the management and use of water. WRE was established to respond a suite of problems, including short-term challenges posed by sustainability reductions and drought plus longer-term problems associated with climate change and population growth. WRE is seeking a strategy which addresses all of these problems and which accommodates the range of potential future conditions. WRE's overall aim is to deliver a reliable, sustainable and affordable system of water supply to meet multi-sector requirements (including the environment) across the East of England for the next 50 years and beyond towards the end of the century. Within this overall aim, the objectives for the project are to: • Provide a framework for collaboration and shared decision making by stakeholders from across key sectors (Water Companies, Agriculture, Energy and Environment) together with Regulators (e.g. Environment Agency, Natural England). • Deliver a water resource strategy to meet unprecedented threats from growth and climate change. The challenge is to provide reliable, affordable supplies of water from sustainable sources which are resilient to the effects of severe drought. • To protect and enhance the environment beyond statutory requirements such as the Habitat Regulations and the Water Framework Directive to provide where possible a net gain in biodiversity • Develop a strategy that supports the policy objectives of Government described in the water white paper "Water for Life"; in particular, supporting economic growth while simultaneously protecting the environment. The proposed approach for the WRE technical assessment is a customised framework, based upon Robust Decision Making (RDM). At its heart is a Regional Simulator which is informing our understanding of vulnerabilities in the existing water supply system and to identify investment in measures which will enable the overall aim of WRE to be met across a range of potential future conditions. The inclusion of environmental protection and enhancement in the overall aims of WRE has driven the development of a bespoke hydroecological module. By incorporating this module in the Regional Simulator, environmental protection and enhancement is an integral part of the decision making process. This presentation describes the challenges facing the east of England. The RDM and the Regional Simulator are outlined, highlighting the technical challenges which had to be overcome when developing the hydroecological module. The presentation focuses on the development of the hydroecological module and the presentation of results. Finally, the suite of supporting investigations are summarised, which have been conducted to add context to the Regional Simulator and to verify its outputs. This presentation has been prepared with the kind permission of Anglian Water, informed by work led by Atkins, Mott MacDonald, University of Manchester and Cranfield University and the support of a wider Technical Steering Group. The views presented are those of the authors.

Quantifying long-term macroinvertebrate community responses to groundwater abstraction practices.

James. C. White David. M. Hannah Andy. House Paul. J. Wood

Loughborough University (J. White and P. Wood) University of Birmingham (D. Hannah) Wessex Water (A. House)
Presenter: James White
Type of Presentation: ORAL

Abstract
The flow regime within lotic environments is widely regarding as a primary factor shaping the structure and function river ecosystems. Hydrological alterations in such environments via various anthropogenic activities, including flow regulation and water abstraction practices, have proven to degrade the ecological integrity of river environments in many instances. Quantifying biotic responses to flow regime alterations is required to advise management strategies and guide the rehabilitation of degraded waterways. However, the ecological implications of groundwater abstraction practices have been historically understudied relative to other forms of flow regime modifications (e.g. impoundments). In this study, we quantify the long-term macroinvertebrate community responses to antecedent flows and groundwater abstraction pressures. Both the structure and function of macroinvertebrate communities were found to be sensitive to inter-annual changes in hydrological variability and were significantly associated with groundwater abstraction. Results from this study highlight the benefits of examining long-term ecological responses to observed hydrological variability and modelled groundwater abstraction practices. Future studies should aim to explore such ecohydrological associations across a range of hydroclimatic regions. Such techniques could be utilized to guide the development of environmental flow strategies and water resource management practices globally.

Sustainable Lahar Disaster Risk Mitigation through Community-based Hydrology-Hydraulics Monitoring and Warning System

Robby Hambali 1) Djoko Legono 2) Rachmad Jayadi 3)

Universitas Gadjah Mada, INDONESIA
Presenter: Djoko Legono
Type of Presentation: ORAL

Abstract
Rivers originated from the summit of Mt. Merapi are very potential to contribute lahar flow due to the instability of the lava dome formation at the summit and heavy rainfall intensity on the area of Mt. Merapi. The Mt. Merapi is considered the most active volcano in Indonesia which erupts very frequent, such as once every five years for the small eruption and once every ten years for the big eruption. The 2010 Mt. Merapi eruption is considered big where the similar one took place in 1006. Some efforts have been made to mitigate the risk due to the lahar disaster as caused by the activity of Mt. Merapi, both through the hard and soft countermeasure. The

development of hard countermeasure by means of sabo structures has shown the evidence that all stakeholders including local community still need to realize that limitation remain persist that disaster may take place in any time and any scale. This paper describes the long efforts in introducing the non-structural countermeasure in the form of establishing hydrology-hydraulics monitoring system at several location at Mt. Merapi area. The community-based approach by participating the local community in the process of establishment and the development of warning criteria of the rainfall threshold contributing the lahar occurrence has become the major discussion of this paper, including the role of the developed system for sustainable program on lahar disaster rick mitigation.

Restoration practices and process in France

Yves Souchon, Research Director, Irstea Hydroecology, Lyon Villeurbanne, France

Presentor: Yves SOUCHON

Type of Presentation: ORAL

Abstract

Restoration is included in French politic agenda for at least 30 years. But behind the term "restoration", there was a great variety of measures: greening of "traditional" engineering works (i.e. flood defense, weirs to stop erosion…), local fish instream habitat addition, fish passages, green infrastructures (riparian areas replanting), morphological alterations. The projects initiatives were also very diverse, but in general due to local decisions at rather local scale. Monitoring was very rare, excepted for minimum flows alteration since 1984 ("Fish law").

In 2000, the WFD introduced new requirements:

- policy efficiency has to be based more on results rather than on means of action;
- results have to be translated in terms of ecological endpoints defined as "ecological status" and evaluated from different biological groups (not fish exclusively);
- overall screening of all waterbodies (WB) consists of (i) a monitoring assessment for around 1/3 of the WB and (ii) a risk based assessment by means of screening the negative hydromorphological pressures in WB without monitoring data.

This new context has introduced new challenges, new practices and new relationships between stakeholders and environmental agencies.

First of all, WFD reinforces the necessity to define a strategic approach at the scale of districts, i.e. Water Agencies areas in France (Rhône, Loire, Garonne,...). We describe the original methodology developed and applied at the national level to audit the hydromorphology (HM) of all running waters WB. This methodology is known as Syrah for SYstem Relative to Audit Hydromorphology. Syrah is a GIS tool which combines spatially different data (direct values and proxies) likely to modify the physical functioning or the physical structure of the WB. Then, Syrah variables help analyze spatial and cumulative risks and hierarchize the most suitable measures to restore the hydromorphology. This strategic screening is used to assist in defining the outline of the SDAGE, Directive Scheme or Broad action plan for PoM (Program of Measures).

In practical terms, the initiative of putting the restoration in practice always belongs to the local actors. A complex interplay exists between land owners, nature defense, economic water uses, al of them varying among regions. A recent law on decentralization (Notre/Gemapi) introduces the necessity to combine two management logics previously administratively cut off from each other: running water protection and flood defense. The scale of decision will be the municipality town in 2018, which is quite new in a traditionally centralized system.
We describe this temporal evolution with examples. We also synthesize the funding trends allocated to restoration versus water quality (Wastewater treatment Plants). We try as well to describe the current controversies about restoration especially dam removal and ecological efficiency (what targets of success, at what time after measures, what ecological gain?). And finally, we question what science could provide to highlight the debates.

The importance of being uncertain (when communicating groundwater model predictions)

Kate L Holland 1 Helen Beringen 2 Luk Peeters 1 Russell Crosbie 1

CSIRO
Presentor: Kate Holland
Type of Presentation: ORAL

Abstract
Numerical models are an important contribution to the assessment of potential environmental impacts. Uncertainty analysis, where potential sources of uncertainty in model predictions are analysed using quantitative or qualitative techniques, are used to build confidence in model predictions. However, while the techniques to quantify the effect of potential sources of uncertainty are well documented, there remain challenges to the effective communication of predictive uncertainty that instil confidence in the model and its predictions. Potential sources of uncertainty include model inputs, parameters, comparison with historical observations, system conceptualisation and scenario description. This paper describes the challenges and solutions used in the communication of the uncertainty analysis framework developed for the Bioregional Assessment Programme in Australia. Bioregional assessments are independent scientific assessments of potential cumulative impacts of coal resource development on water resources and water-dependent assets such as rivers, wetlands and groundwater systems. The uncertainty analysis framework developed for bioregional assessments is centred around explicitly defining objectives and implements a comprehensive and flexible uncertainty quantification and sensitivity analysis that is complemented by a systematic discussion of model assumptions. The quantitative and qualitative uncertainty analysis techniques are used to build confidence in the prediction of potential hydrological changes due to coal resource development. Numerical models are run hundreds or thousands of times to quantify the sensitivity of model predictions to input parameters, such as the physical properties, porosity and hydrological connectivity of geological layers using a credible range of possible input parameters. The resulting range of possible

model predictions is a high-dimensional dataset, which is challenging to visualise and summarise. The often very skewed distributions of model predictions can be simplified for the reader by focusing on the probability of exceeding a specified threshold or percentile estimates of a model output, e.g. groundwater drawdown. The summary statistics help to communicate the range of potential results and also the degree of confidence in model predictions, but can also lead to selection of a single percentile that supports a particular narrative, depending on the perspective of the reader. Instead, the reader can be guided on the interpretation of the range of predictions to reduce the potential for misinterpretation of model predictions. Bioregional assessments have used a conservative percentile to rule-in and rule-out impacts, maps and diagrams to describe the range of estimates and emphasised the median or mid-point of estimates in the text. The formal qualitative uncertainty analysis describes the effect of model assumptions, data, resource and technical limitations on model predictions. The explicit discussion of model assumptions and systematic qualitative uncertainty analysis can be used to prioritise future investment in models, data and system conceptualisation to improve future environmental impact assessments. The open and transparent communication of the uncertainty associated with the environmental impact assessment ultimately improves confidence in the model and its predictions.

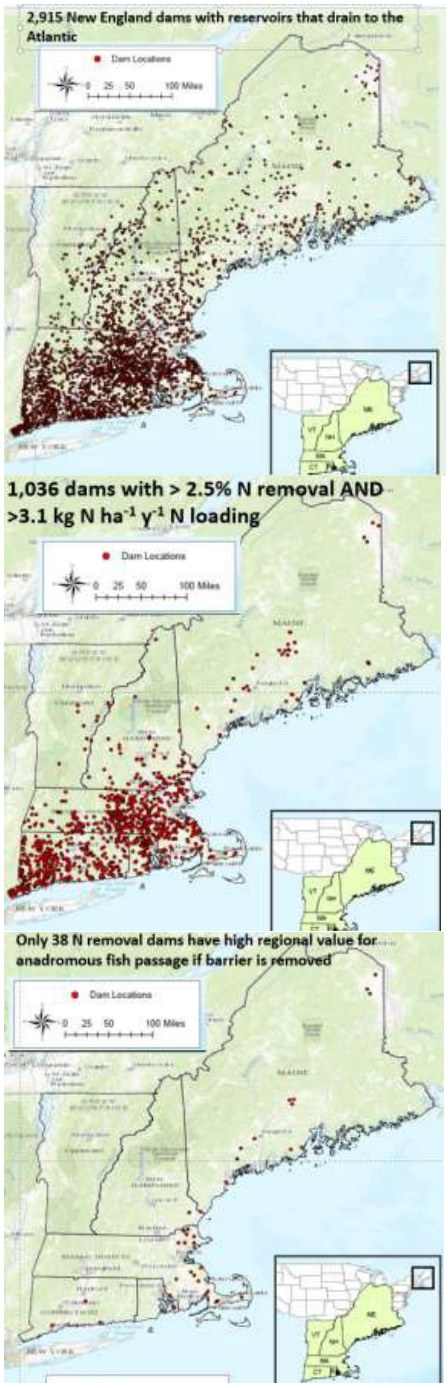
Will Dam Removal Increase Nitrogen Flux to Estuaries?

Arthur J. Gold 1,*, Kelly Addy 1, Marissa Simpson 1 and Alisa Morrison 2

University of Rhode Island
Presenter: Professor Arthur Gold
Type of Presentation: ORAL

Abstract
Dam removal is attracting increasing attention to promote fish passage and reduce safety risks. However, reservoirs associated with dams may serve as “hot-spots” of watershed nitrogen removal. Watershed nitrogen (N) loading to estuaries can accelerate eutrophication, degrading habitats, altering species composition and generating fish kills. We used the 200,000 km2 New England (USA) region to examine possible dam removal tradeoffs between increased flux of N to coastal watersheds and improvements in safety or migratory fish passage. We evaluated over 7,500 dams to estimate N removal with algorithms that use geospatial data on land use, stream flow and hydrography. Approximately 2,000 dams associated with reservoirs were found to have potential benefits for N removal. Across a range of stream orders (small to large rivers) safety concerns on these N removal dams ranged between 29-43%. The majority (> 70%) of N removal dams were located on relatively small first order streams, but only 3% were classified as high value for migratory fish passage. Dams deemed to be high priorities for barrier elimination, based on value to migratory fish, constituted a larger proportion (> 20%) of the dams on higher order streams. Magilligan et al. (2016; Elementa) argued for removal strategies that focus on a select group of dams on large watersheds with large tracts of high quality habitats. Our results suggest that this approach will also

minimize changes in N flux to coastal estuaries, since few N removal dams were found on large watersheds and most of those were associated with low levels of N loading (kg ha-1 y-1). However, given the relatively small number of dam removals occurring annually in New England, studies on the effects of site-specific dam removals on N loading to individual estuaries is recommended.



Gold, Arthur. Will dam removal increase nitrogen flux to estuaries?

Impact of reservoirs on global carbon cycle changes through development of advanced eco-hydrologic and biogeochemical coupling model

Tadanobu Nakayama, and Shamil Maksyutov

National Institute for Environmental Studies
Presenter: Dr Tadanobu Nakayama
Type of Presentation: ORAL

Abstract

Recent research shows inland water may play some role in continental carbon cycling though its contribution has remained uncertain due to a paucity of data (Battin et al., 2009). Further, the increasing number of reservoirs might alter water and nutrient cycles and ecosystem dynamics significantly, and in particular, hydroelectric reservoirs are identified as potentially important sources of greenhouse gas emissions (Barros et al., 2011). So, it is considered that hydrologic and carbon cycles are greatly affected and become more complex by the reservoirs. The author has so far developed process-based National Integrated Catchment-based Eco-hydrology (NICE) model (Nakayama, 2014, 2015), which incorporates surface-groundwater interactions, includes up- and down-scaling processes between local-regional-global scales, and can simulate iteratively nonlinear feedback between hydrologic-geomorphic-ecological processes. This model was applied to various catchments/basins (Changjiang, Yellow, Mekong, and West Siberia, etc.) and expanded to global scale in order to evaluate eco-hydraulic and eco-hydrological processes there. Recently, NICE was further developed to couple with various biogeochemical cycle models in biosphere, those for water quality in aquatic ecosystems, and those for carbon weathering, etc. (NICE-BGC) (Nakayama, 2016, in revision). The new model incorporates connectivity of the biogeochemical cycle accompanied by hydrologic cycle between surface water and groundwater, hillslopes and river networks, and other intermediate regions. The model also includes reaction between inorganic and organic carbons, and its relation to nitrogen and phosphorus in terrestrial-aquatic continuum. The model results of CO2 evasion to the atmosphere, sediment storage, and carbon transport to the ocean (DOC, POC, and DIC flux) were reasonably in good agreement with previous compiled data, and showed carbon budget in major river basins in global scale. In this study, NICE-BGC was further extended to include the effect of major reservoirs on global carbon cycle changes. The simulated result showed that carbon transports to the ocean decrease and vertical fluxes increase by the effect of reservoirs. The spatial distribution of these flux changes simulated by the model was compared with the flux observations in the previous research (Barros et al., 2011), and evaluated the reasons of difference in some regions. NICE-BGC would play important role to re-evaluate greenhouse gas budget of the biosphere, and to bridge gap between top-down and bottom-up approaches (Battin et al., 2009). Reference; Barros, N., et al., Nat. Geosci., 4, 593-596, 2011. Battin, T.J., et al., Nat. Geosci., 2, 598-600, 2009. Nakayama, T., Hydrology–ecology interactions. In: Handbook of Engineering Hydrology, CRC Press, pp.329-344, 2014. Nakayama, T., Integrated assessment system using process-based eco-hydrology model for adaptation

strategy and effective water resources management. In: Remote Sensing of the Terrestrial Water Cycle. Geophysical Monograph Series 206, AGU, pp.521-535, 2015. Nakayama, T., New perspective for eco-hydrology model to constrain missing role of inland waters on boundless biogeochemical cycle in terrestrial-aquatic continuum. Ecohydrol. Hydrobiol., 16, 138-148, 2016. Nakayama, T., Development of an advanced eco-hydrologic and biogeochemical coupling model aimed at clarifying the missing role of inland water in the global biogeochemical cycle. J. Geophys. Res., in revision.

Stream restoration enhances hyporheic fine particle exchange

J. D. Drummond1,2, L. G. Larsen3,4, R. González-Pinzón5, A. I. Packman2, J. W. Harvey3

Centre for Advanced Studies of Blanes (CEAB-CSIC)
Presenter: Dr Jennifer Drummond
Type of Presentation: ORAL

Abstract
Stream restoration is a multibillion dollar/euro industry that aims to reestablish not only natural morphology, but also key hydrological and ecological functions. Key functional targets of stream restoration include slowing in-stream transport, increasing hyporheic exchange, and promoting biogeochemical processes in restored reaches. Restoration often includes a mixture of in-channel structures and bank stabilization to promote exchange with transient storage areas. Fine particles (<100 μm) are known to transport with solute into transient storage areas, directly impacting carbon and nutrient cycling and fine sediment export downstream. However, little is known on how fine particle process dynamics respond to stream restoration. Accumulation of fine particles within the sediments can cause clogging, which impacts the hydraulic conductivity and oxygen flux into the hyporheic zone. On the other hand, the presence of particulate organic matter within sediments increases both microbial abundance and biogeochemical processing. We analyzed the transport and retention of solute and fine particles within a restored stream nine years after the installment of cross-vane restoration structures. A conservative tracer and fine tracer particles were injected under summer baseflow conditions, and followed downstream within surface water, porewaters, and transient storage areas. A mobile-immobile model was fit to surface water solute and particle concentration profiles to characterize transport and retention within the stream. We compare these results to those obtained from a similar experiment in an unrestored stream in the same watershed. Benthic biofilms and hyporheic sediments continuously accumulated fine particles through the experiment. Through the direct comparison of a restored and unrestored stream, we demonstrate that in-stream and hyporheic solute uptake was larger in the restored reach, but particle immobilization and filtration coefficients were similar. The increased solute exchange, and thus increased fine particle exchange, did not result in increased fine particle immobilization rates, suggesting that restoration

structures increase exchange while limiting clogging. Thus, this study shows that restoration structures enhance hyporheic fine particle exchange, demonstrating the potential for improved biogeochemical processing in restored streams.

Testing Hydrological Suitability for Mangrove Restoration

Anne F. Van Loon (1), Bram Te Brake (2,3), Marjolein H.J. Van Huijgevoort (4), Roel Dijksma (3)

University of Birmingham
Presenter: Dr Anne Van Loon
Type of Presentation: ORAL

Abstract
Mangrove restoration projects, aimed at restoring important values of mangrove forests after degradation, often fail because hydrological conditions are not properly restored. We present a simple, but robust methodology to determine hydrological suitability for mangrove species, which can guide restoration practice. In 15 natural and 8 disturbed sites (i.e. disused shrimp ponds) in three case study regions in south-east Asia, water levels were measured and vegetation species composition was determined. Using a hydrological classification for mangroves, sites were classified into hydrological classes, based on duration of inundation, and vegetation classes, based on occurrence of mangrove species. In the natural sites, hydrological and vegetation classes were similar, showing a clear differentiation of mangrove species between wet and dry sites. Application of the classification to disturbed sites showed that in some locations hydrological conditions had been restored enough for mangrove vegetation to establish, in some locations hydrological conditions were suitable for various mangrove species but vegetation had not established naturally, and in some locations hydrological conditions were too wet for any mangrove species (natural or planted) to grow. We quantified the effect that removal of obstructions such as dams would have on the hydrology and found that failure of a restoration project at one site could have been prevented. In this presentation we will discuss the use of a hydrological classification in mangrove restoration projects compared to using elevation only. We conclude that the hydrological classification gives important information about how to restore the hydrology to suitable conditions to improve natural regeneration or to plant mangrove species, which could not have been obtained by estimating elevation only. Based on this research a number of recommendations are given to improve the effectiveness of mangrove restoration projects. Session: S7: Ecohydrology in restoration practice - ecosystem management, engineering and society

S8. New experimental and modelling methods for investigating groundwater - surface water interactions

Conveners: Adam Ward, Jesus Gomez

Hydrologic Connectivity of River Corridors

Durelle Scott-2 Elizabeth Boyer-3 Jesus Gomez-Velez-4

U.S. Geological Survey
Presentor: Jud Harvey-1
Type of Presentation: ORAL

Abstract
Longitudinal transport in rivers and wetlands is integrated with vertical and lateral exchanges with hyporheic zones, floodplains, and ponded off-channel waters where carbon and nutrients are stored and processed, and where aquatic organisms feed, or are reared, or take refuge during floods. What degree of longitudinal connectivity, versus vertical and lateral connectivity promotes a healthy river?, i.e., a river with proper levels of stream metabolism, diverse food webs, and robust rates of contaminant processing that protects water quality? We are engaged in quantifying hydrologic connectivity throughout river corridors of the conterminous U.S. by estimating vertical and lateral hydrologic exchange flows and comparing those fluxes with longitudinal transport along the main axis of flow. In many cases vertical and lateral exchange flows are large enough to exchange the main channel's entire volume many times within a river network, which increases biogeochemical opportunities for nutrient processing, sediment redistribution, and attenuation of contaminants. Further characterization examines basin surficial geology, slope, grain-size, etc. as controlling factors, distinctions such as stream order and other characteristics of channels that promote water quality functions, as well as implications for management practices to protect river corridor water quality.

Hydrological and microbial controls on oxygen consumption along bed forms

Natalie De Falco-1 Shai Arnon-1 Edo Bar Zeev-1 Dario Vello-2 Fulvio Boano-2

Ben-Gurion University of the Negev
Presenter: Shai Arnon
Type of Presentation: ORAL

Abstract
Recent studies have demonstrated that bed forms are the most significant geomorphological structure that drives hyporheic exchange and biogeochemical processes in stream networks. Other studies also demonstrated that due to the hyporheic flow patterns within bed forms, biogeochemical processes do not occur uniformly along and within the bed forms. The objective of this work was to evaluate the relative contribution of hydrological forcing versus microbial distribution to the differences in oxygen consumption along the bed forms. This

research question was studied in a recirculating indoor flume under different overlying flow velocities and losing and gaining fluxes. Oxygen profiles were measured using microelectrodes, and oxygen consumption was calculated from the profiles by using a novel modeling tool (GRADIENT). GRADIENT finds the reaction rate distribution that best fits the observed concentrations in the sediments in presence of solute transport by advection and diffusion. Small pieces of dried leaves were spread evenly on the bed forms as a carbon source. In the first set of experiments, sediment was mixed before each measurement to verify that biomass is distributed evenly along the bed forms. The second set of experiments started after a two month biofilm growth period, which resulted in a non-even biomass distribution along the bed forms. The oxygen consumption rates were normalized to bacterial biomass by counting bacteria concentrations from the sand along the bed forms using flow cytometry. Concurrently, microbial activity was also measured using a 3H-leucine incorporation approach. The experimental observations and modeling revealed that oxygen distribution varied along the bed forms, even when biomass was evenly distributed in the streambed. The zone of oxygen consumption was the largest at the stoss side (upstream) of the bed form and the smallest in the lee side (at the lowest part of the bed form), regardless of the flow conditions. Also, oxygen consumption was the largest under losing conditions, the smallest under gaining conditions, and in-between under neutral conditions. The results with non-even distribution of biomass were recently obtained and are now under evaluation. Our preliminary results enable us to show the importance of the coupling between flow conditions, biomass distribution and oxygen consumption along bed forms and are expected to improve our modeling the effect of stream-groundwater interactions on nutrient cycling

How old is your streambed?

Michael J. Stewardson Meenakshi Arora Roser Casas-Mulet Shivansh Shrivastava Priyaga Fernando Garima Lakhanpal

The University of Melbourne
Presenter: Michael Stewardson
Type of Presentation: ORAL

Abstract
The recirculation of streamflow through streambed sediments contributes to a variety of ecosystem functions including retention of nutrient and contaminants and the provision of permanent or temporary aquatic habitats. Whilst these functions have received a lot of attention in the literature and river management practice, the bio-physical nature of the sediment matrix, including both its spatial variability and its evolution with time is often neglected. This paper makes the case that river managers should pay attention to the evolving condition of the river sediments. A conceptual model is presented for the evolution of streambed sediment including: resetting with bed mobilisation; subsequent physical and biological clogging; and

interactions with bioturbation by animals and plants. The conceptual model is tested in an empirical analysis of streambed surveys in over 100 river reaches. The conceptual model has important implications for management of flow regimes and river channels.

Identification of pattern and fluxes of groundwater-stream water exchange in a heterogeneous sand-bed stream by fibre optic distributed temperature sensing

Jaime Gaona (a,b,c), Jörg Lewandowski (a,d)

Leibniz Institut of Freshwater Ecology and Inland Fisheries / Freie Universität Berlin
Presenter: Mr Jaime Gaona
Type of Presentation: ORAL

Abstract
Groundwater-stream water interactions are essential for hydrology, chemistry and biology of streams and aquifers. The study of this exchange requires the combination of different techniques to understand the underlying processes at different scales. Here we combine thermal point and distributed techniques and apply them to a small sand-bed stream in Germany. Fiber optics distributed temperature sensing (FO-DTS) is useful for the identification of thermal patterns at the streambed surface. Due to its spatial flexibility, a FO-DTS measurement arrangement enables to target simultaneously channel cross sections and stream reaches. Fluxes are calculated from temperature depth profiles (point technique) at sections of representative hydraulics, riverbed forms and sediment properties. Then, a transfer function can be used to estimate the distribution of fluxes based on the FO-DTS map. However, multiple factors affect streambed temperature and fluxes in depth of the sediment and at the different locations, which define a 3D heterogeneity of temperature and flux patterns. The results of our study show the virtues of FO-DTS for cross-scale investigation of river-aquifer interactions, while they highlight the limitations of the technique for flux estimation. Regarding temperature depth profiles, the study shows the advantages of this point technique for characterizing hyporheic zone heterogeneity. Point and distributed techniques have complementary capabilities that require a statistical model to link the variability of riverbeds with the variability of thermal patterns identified by FO-DTS. We conclude that flux estimates linking point and distributed measurements fail to accurately upscale fluxes due to the intrinsic limitations of thermal flux estimations and the limited capabilities of statistical models to handle the complex drivers and controls, especially streambed morphology. Consequently, upscaling of groundwater-stream interactions by combining point and distributed techniques requires the integration of hydraulic streambed properties and morphological investigations.

BEST Engineered Hyporheic Zones: Enhanced Hyporheic Exchange and Resazurin and Nitrogen Cycling in Constructed Stream Experiments

Skuyler Herzog, Andrea Portmann, Brittnee Halpin, Christopher Higgins, John McCray

Colorado School of Mines
Presenter: Ms Andrea Portmann
Type of Presentation: ORAL

Abstract

The hyporheic zone (HZ) is a natural bioreactor within the streambed that can attenuate a variety of nonpoint source contaminants. Nonpoint source pollution commonly arises from urban stormwater and agricultural runoff, which both adversely impact aquatic environments. Stormwater pollutants of concern often include nutrients, metals, pathogens, and micropollutants. Despite substantial water quality challenges, current stormwater management typically prioritizes storm flow volume reduction rather than pollutant removal, therefore rarely considering the HZ. However, the HZ has been gradually gaining attention, especially in stream restoration, due to its unique role in improving chemical and thermal water quality. Nevertheless, HZs in urban and agricultural streams are often degraded and poorly connected with surface water. Furthermore, current HZ restoration best management practices do not explicitly control HZ residence times, and have not been shown to be consistently effective at the reach-scale. To increase hyporheic exchange and improve water quality, we introduced engineered streambeds as a stormwater and restoration best management practice. Modifications to streambed hydraulic conductivity (K) and reactivity are called Biohydrochemical Enhancements for Streamwater Treatment (BEST). BEST alterations include subsurface modules that utilize low-permeability sediments to drive efficient hyporheic exchange, and permeable reactive geomedia to increase reaction rates within the HZ. This research was conducted using two 15m long artificial stream flumes at the Colorado School of Mines in Golden, CO, which were continuously dosed with recycled water at 0.25 L/s. One flume served as an all-sand control condition, the other featured BEST modules at 1m spacing with a mixture of 70/30 sand/woodchips (v/v). NaCl breakthrough curves were monitored and analyzed using STAMMT-L, a mobile-immobile exchange model, which showed greater hyporheic exchange and residence times in the BEST stream relative to the control. This result is even more apparent when the calibrated models are used to simulate longer stream reaches. Water quality samples at the reach scale also revealed greater attenuation of nitrogen and transformation of the indicator compound resazurin into resorufin. Together these compounds demonstrate that BEST can attenuate contaminants that degrade under aerobic conditions. Furthermore, spike experiments involving the widely used herbicide atrazine showed 43% removal in the BEST system compared to 2% removal in the control, suggesting that BEST may generally be effective for pesticide attenuation in streamwater. Ecological benefits of applying BEST include increased exchange between streamwater and HZ water,

leading to diverse habitat and redox conditions that are beneficial for aquatic organisms and will facilitate in-stream pollutant transformation. Altogether, these results show that BEST may be an effective novel best management practice for improving streamwater quality in urban and agricultural settings. Future work will focus on optimizing the BEST design for specific pollutants, thereby controlling HZ residence times to match reaction timescales and conditions of interest.

Quantifying Lake – Groundwater Interactions in an Inland Lake: Field Experiments and Numerical Modeling

Ammar Safaie1 Elena Litchman2,3 Mantha S. Phanikumar1

Michigan State University
Presenter: Mantha Phanikumar
Type of Presentation: ORAL

Abstract
With groundwater levels declining in many parts of the world, there is an urgent need to understand how lake ecosystems are being impacted by the changing nature of groundwater - surface water (GW-SW) interactions. To address this question, we used extensive field datasets and coupled process-based models of lake - groundwater systems to quantify GW-SW interactions in a relatively small but deep, dimictic inland lake in Michigan, USA. We combined temperature data from thermistor chains, current and water level data from acoustic Doppler current profilers with GW data from wells to quantify the GW contribution to circulation and thermal structure within the lake. We then evaluate the role of GW on hypolimnetic temperatures, dissolved oxygen, nutrients and algal dynamics within the lake. Our results are expected to aid in understanding the role of GW on several key biophysical processes that affect the structure and function of lake ecosystems.

Integrating theory, experimentation, and modeling for multiscale assessment of hyporheic exchange

Aaron I. Packman, Kevin R. Roche, Angang Li, Colin B. Phillips

Northwestern University
Presenter: Dr Aaron Packman
Type of Presentation: Poster

Abstract
Surface-groundwater interactions occur ubiquitously and nearly continuously over topographic scales ranging from individual sediment grains to large mountain valleys. However, all available measurement methods only capture a relatively narrow window of scales, and all models also involve explicit or implicit assumptions that restrict the range of scales that they represent accurately. These challenges are exacerbated by the fact that hyporheic exchange fluxes, porewater velocities, and measurement sensitivities all generally decrease with increasing scale. These limitations present a massive problem for evaluating true multiscale

hyporheic exchange, especially in the context of biogeochemical cycling that may be spatially restricted to thin interfaces and hotspots. It is important to recognize that all upscaled measurements of surface-groundwater exchange and associated biogeochemical process rates reflect integration over a wide range of scales. Therefore, the solution to this problem requires both a strong theoretical framework for integrating disparate measurements across scales, and independent identification of regions where exchange has special interest for biogeochemical cycling. We will outline a well-posed theoretical framework for upscaling based on current stochastic transport theory for highly heterogeneous systems, and discuss the utility and limitations of available theory for integrating hyporheic exchange processes across scales. We will also use a combination of laboratory data and model simulations to illustrate how coupling processes regulate hyporheic transport and biogeochemistry even at relatively small spatial scales. Finally, we will discuss implications for upscaling biogeochemical process rates at river reach and network scales.

How river-groundwater connectivity controls nutrient dynamics in a mesoscale catchment

Jan H. Fleckenstein1, Andreas Musolff1, Ben Gilfedder2, Sven Frei2, Fabian Wankmüller2
& Nico Trauth1

Helmholtz Center for Environmental Research, UFZ
Presenter: Prof Jan Fleckenstein
Type of Presentation: ORAL

Abstract
The export of solutes from diffuse sources in catchments is governed by complex runoff generating processes, which in turn are affected by a suite of interrelated factors such as land use, climate, geological-/ hydrogeological setup and morphology. Those factors create spatial variations in solute concentrations and turnover rates in the subsurface as well as in the stream network. River-groundwater connectivity is a crucial control in this context: On the one hand groundwater is often a main pathway for nitrate input to streams. On the other hand, groundwater connectivity with the stream affects the magnitude of hyporheic exchange of stream water with the stream bed. We present results of a longitudinal sampling campaign along the Selke river, a 67 km long third-order stream in central Germany. Water quality at the catchment outlet is strongly impacted by agriculture with high concentrations of nitrate and a chemostatic nitrate export regime. However, the specific nitrate pathways to the stream are not fully understood as there is arable land distributed throughout the catchment. While the sparsely distributed arable land in the mountainous upper catchment receives much higher amounts of precipitation, the downstream alluvial plains are drier, but more intensively used. The field campaign was conducted in June 2016 under constant

low flow conditions. Stream water samples were taken every 2 km along the main stem of the river and at its major tributaries. Samples were analyzed for field parameters, major cations and anions, N-O isotopes, nutrients and Radon-222 (Rn) concentrations. Additionally, at each sampling location, river discharge was manually measured using current meters. Groundwater influxes to each sampled river section were quantified from the Rn measurements using the code FINIFLUX, (Frei and Gilfedder 2015). Rn and ion concentrations increased from the spring to the mouth, indicating growing groundwater fluxes to the river. However, increases in groundwater gains were not gradual. The strongest gains were observed downstream of where the Selke River leaves the Harz Mountains and enters the alluvial plains. At this location, land use, hydrogeological setup and river slope as well as average slope of the contributing catchment area change significantly. Downstream of this point 15N isotope values were significantly higher, suggesting higher denitrification activity in the deeper aquifers of the lower catchment. While specific discharge (discharge per catchment area) was 3 times higher in the upper catchment, nitrate mass flux per area was more than 3 times higher in the lower catchment compared to the respective other parts of the catchment. We conclude that catchment morphology, (hydro)geology and hydrology control river-groundwater connectivity while the interplay with land use controls in stream nitrate concentrations. Repeated sampling campaigns will allow assessing seasonal changes in solute inputs and turnover. Frei, S. & Gilfedder, B.S. (2015): FINIFLUX: An implicit finite element model for quantification of groundwater fluxes and hyporheic exchange in streams and rivers using radon. Water Resources Research, DOI: 10.1002/2015WR017212.

A new approach to using streambed thermal signatures to charaterise spatio-temporal patterns of transitory groundwater-surface water interactions

Mark Cuthbert (1,2,3) Gabriel Rau (3,4) Landon Halloran (3,4) Martin Andersen (3,4) Ian Acworth (3) John Tellam (5)

Institution:
Presenter: Dr Mark Cuthbert
Type of Presentation: ORAL

Abstract

Despite ephemeral or intermittent streamflow occurring in the majority of the world's river networks, the spatio-temporal dynamics of transitory groundwater-surface water interactions are poorly understood. Here we present a new method to characterise water flow in variably saturated streambeds which takes advantage of the contrast in diel thermal signatures between dry and saturated conditions. We show how this can be used to detect and characterise short-lived stream flow and groundwater-surface water interactions, first outlining the theory, and then demonstrating the technique using a novel data set from the Maules Creek catchment in NSW, Australia. Analysis of the thermal signatures illustrates that short-lived groundwater-surface water interactions are highly variable in space and time but that a distinct cycle of hydrological regimes can be defined as follows: (1)

dry channel, (2) surface runoff, (3) pool-riffle sequences, (4) drying pools. The rate of subsurface redistribution of infiltrated water controls the duration of the pool-riffle sequences regime, which either leads to ephemeral or intermittent stream flow behaviour, and is governed primarily by the heterogeneity of sediments along the channel. Our new approach can be used to better understand how transitory flow regimes support dryland ecology, influence water quality variations, and control rates and spatial distributions of groundwater recharge. Suggested for session: S8 - New experimental and modelling methods for investigating groundwater – surface water interactions

Dynamic network expansion, contraction, and connectivity in the river corridor of mountain stream networks

Adam S. Ward Noah M. Schmadel Steven M. Wondzell

Indiana University
Presenter: Adam Ward
Type of Presentation: Oral

Abstract
River networks are broadly recognized to expand and contract in response to hydrologic forcing. Additionally, the individual controls on river corridor dynamics of hydrologic forcing and geologic setting are well recognized. However, we currently lack tools to integrate our understanding of process dynamics in the river corridor and make predictions at the scale of river networks. In this study, we develop a perceptual model of the river corridor in mountain river networks, translate this into a reduced-complexity mechanistic model, and implement the model in a well-studied headwater catchment. We found that the river network was most sensitive to hydrologic dynamics under the lowest discharges (Qgauge < 1 L s-1). We also demonstrate a discharge-dependence on the dominant controls on network expansion, contraction, and river corridor exchange. Finally, we suggest this parsimonious model will be useful to managers of water resources who need to estimate connectivity and flow initiation location along the river corridor over broad, unstudied catchments.

Development of compartment model on primary and secondary production at pool and riffle structure in Japanese river middle reach

Masatoshi DENDA Yuichi KAYABA Kimio HIRABAYASHI

PUBLIC WORKS RESEARCH INSITUTUTE
Presenter: Dr Masatoshi DENDA
Type of Presentation: ORAL

Abstract

Purpose In river ecosystems, riffle and pool structures influence ecological functions such as biological productivity including primary production (from plants) and secondary production (from animals). At present, in Japanese rivers, the decrease of fishery resources such as fresh-water fish species is an important environmental issue. Some researchers hypothesize that the issue is caused by changes in biological productivity due to degradation of pool-riffle structures. In addition, extreme variations in precipitation patterns increases flood risk. To avoid such degradation and to maintain biological productivity, we must clarify the influence of pool-riffle structures on biological productivity through field observation and model simulations. In addition, these processes are influenced by the hydrology of flow regimes. We must research biological productivity as an integrated system consisting of hydrology, runoff, and hydrological and biological processes. In this study, as a first step toward researching the background of this issue, we started to clarify biological productivity through field observation and model studies in the Chikuma River, a high-productivity Japanese river. 2. Methods In general, Net Primary Production (NPP) equals Gross Primary Production Including Respiration (GPPIR) minus Grazing Biomass (GB) and Detachment Biomass (DB), as formulated mathematically in Equation (1): NPP = GPPIR - (GB+ DB) (1) Because detachment phenomena instantaneously occur at both micro-scales and over wide areas, observation of DB is extremely difficult. However, NPP and GPPIR can be reliably observed in field surveys and GB can be estimated. Therefore, we calculated DB using Equation (2) and verified DB through comparison with field observation data: DB = GPPIR - NPP - GB (2) First, we conducted field observations. We measured monthly GPPIR by our developed field-chamber method, which reflects light and thus river-water quality. We also conducted monthly observations in order to measure and calculate NPP using the biomass method. Second, we estimated GB using field observation data of fish and aquatic insect communities. GB can be described by Equation (3): GB = ARa* Pa* INa + ARf* Pf* INf (3). where ARa: Assimilation rate of aquatic insect; Pa: Productivity of aquatic Insect; INa: Individual number of Aquatic Insect; ARf: Assimilation rate of fish; Pf: Productivity of fish; INf: Individual number of fish. We calculated changes in average wet weight among every year's class and estimated the biomass change of each aquatic insect and fish. To estimate IN, we surveyed the Inhabitant Density (ID) of aquatic insects and fish and estimated their Habitat Area (HA) using a physical habitat model. We then multiplied ID and HA, calculated the IN, and estimated GB using AR values researched by present studies. To verify the accuracy of these estimates, we conducted field observation on water quality (Organic Matters Concentration, OMC) and compared the concentration of DB to OMC. 3. Results Based on the above procedures, we estimated the DB value as 4.4mg /? while observation data gave an OMC value of 1.5mg /?. The estimated and observed values corresponded approximately in order of magnitude. The productivity framework is influenced by uncertainties such as primary production area, migration of aquatic insects and fish, assimilation rate of aquatic insects and fish, and so on.

Evaluation of Groundwater for Sustainable Development in Siwa Oasis, Egypt Using Integrated Remote Sensing Data and GIS

Ismail Esam

Data Reception, Analysis and Receiving Station Affairs Division
Presenter: Prof Safaa Hassan
Type of Presentation: ORAL

Abstract

Overpopulation of Egypt has put pressure on the government. Therefore, horizontal expansion in the desert for agricultural purposes is very necessary for food security whereas the groundwater is the main source of water supply?. The present study, aims to evaluate the groundwater quality in Siwa Oasis using the integrated data of remote sensing and GIS. To carry out this goal, the data of Thermal Emission and Reflection Radiometer (ASTER) images have been used to discriminate the lithological rock units and for the lineament analysis in the study area. Depending on the qualitative analysis of the ASTER spectral characteristic curves, two ?band ratios (1/5, 8/9, 4/6) and (1/3, 2/5, 4/9) have been selected for accurate lithological ?discrimination. ?ALOS radar remote sensing data with spatial resolution 12.5m has been used to emphasize the predominant fault trends as well as detection of the buried structures and drainage systems in the study area. Thirty nine groundwater samples were collected for chemical analysis as well as to reveal their chemical characteristics. The interpreted data has been used to the preliminary evaluation of the suitability of groundwater for drinking and irrigation purposes by comparing those parameters with world health organization (WHO) standards and Egyptian standards. The present study concluded that, most of the collected water samples are unsuitable for drinking due to the high salinity and the high concentration of iron and manganese. About 82% of the studied water samples showed total hardness ranging between hard and very hard, they are unsuitable for the industry. According to salinity index, SAR, Na%, magnesium hazard and Kelley ratio, most of the collected groundwater samples are considered unsuitable for irrigation purposes.

S9 Ecohydrology interactions with emerging pollutants (incl. microplastics, engineered nanoparticles, pharmaceuticals)

Joerg Lewandowski, Iseult Lynch,

Organic micropollutants in surface water systems – a quick overview

Michael Radke

Institute of Hygiene and Environment
Presenter: Michael Radke
Type of Presentation: ORAL

Abstract

Organic micropollutants are typical contaminants in surface water ecosystems. They are discharged from point sources such as wastewater treatment plants or combined sewer overflows, from more diffuse sources such as agricultural use, contaminated sites or leaking sewers, and some are even deposited from the air. While many non-polar organic micropollutants such as polycyclic aromatic hydrocarbons or polychlorinated biphenyls have been studied extensively for many decades, more polar micropollutants are routinely analyzed for less than 20 years, mainly due to a lack of routine instrumentation for this purpose. Pharmaceuticals and personal care products (PPCPs) are a major group of such polar organic micropollutants. Non-polar chemicals are predominantly bound to suspended solids or sediment particles, and their distribution between these particles and the water phase is governed by equilibrium processes. As a consequence of their high sorption potential, they are rather immobile in rivers and streams and are mainly transported during high discharge events when sediments are remobilized. Release of such contaminants to large stream systems can affect locations far downstream of the point of release even after long periods of time, while there is little chance of predicting exactly when and at which magnitude the contaminant peak will arrive due to the chaotic nature of flood events. This presentation will provide a recent example of this process, with a large potential societal and economic impact. In contrast, polar micropollutants such as PPCPs are highly mobile in rivers and streams, their downstream transport is fast. This complicates studies on their environmental fate, as processes on short time-scales in highly dynamic systems have to be analyzed, and as surface water-groundwater interactions can play an important role in their transformation and degradation. This presentation will provide some background on the occurrence of polar micropollutants in rivers, highlight key findings on their environmental fate, and summarize several knowledge gaps we are currently facing in terms of understanding the involved processes and mechanisms.

Heavy Metal-Microbe Interactions in Aquatic Systems: Challenges and Prospects for the Safeguard of Health and Environment

Ved Pal Singh*, Zeeshanur Rahman and Lebin Thomas

University of Delhi
Presenter: Prof Ved Pal Singh
Type of Presentation: ORAL

Abstract
Heavy metals, being indestructible, remain in the aquatic systems for long time. High industrial density and some natural processes generate tremendous amount of heavy metals, which is continuously discharged into different water bodies/streams. The prevalent wastewater contaminants are arsenic (As), cadmium (Cd), chromium (Cr)(VI), mercury (Hg) and lead (Pb) which pose potential threat to human and animal health, as they are carcinogenic and neurotoxic in nature. Therefore, the main objective of the present investigation was to isolate and characterize the bacteria through heavy metal-micorbe interactions for their health and environmental significance in aquatic systems. Samples from different contaminated sites of Kanpur, Delhi and Chakdaha (West Bengal), India were collected for enumeration of heavy metal resistant bacteria. The experiments were carried out in a period of six years (Dec 2010 to Dec 2016). Bacteria were isolated NB/LB agar media and characterized on the basis of their biochemical, molecular, antibiotic susceptibility and pathogenicity. Our study reports that increasing concentration of Hg at the contaminated sites set a lower abundance of microbial growth. Moreover, the selection pressures of heavy metals at the contaminated sites influence the emergence of heavy metal resistant microflora. We observed that most of the bacteria isolated from contaminated sites were resistant to multiple heavy metals. In another investigation, As-resistant bacteria were isolated and characterized for their bioremediation potential. We have optimized the bioremediation strategies of Cr(VI) and Pb and identified their different mechanisms. Since most of the earlier reports on bioremediation of these heavy metals have been focused only on their optimisation, variants biosafety is highly ignored. In contrast, we have isolated some heavy metal resistant bacteria from contaminated sites/habitats and selected the useful ones on the basis of their non-pathogenicity (i.e. non-haemolytic nature) for bioremediation, so as to safeguard both human and animal health as well as the environment. In our investigation, Cr(VI) and Pb were removed using autochthonous bacteria through reduction and biosorption processes, respectively in aqueous habitats (Table 1). Conclusively, taking the advantage of their diverse biochemical processes, the isolated novel microorganisms are of great health and environmental significance, as they can be used as biological tool for the assessment of heavy metal contamination and their sustainable remediation.

Table 1: Microbial isolates from different contaminated habitats.

Type of bacteri	Taxonomic identification	Sites of collection	Process involved
Cr(VI)-resistant bacteria	*Bacillus cohnii* VP1, *B. cohnii* VP13, *B. licheniformis* VP7, *B. halodurans* VP12 and Enterobacter sp. DU 17	Tannery waste dump sites	Reduction process
Pb-resistant bacterium	*Staphylococcus hominis* AMB-2	Pb-acid battery recycling (PABC) contaminated sites	Biosorption
As-resistant bacteria	*Bacillus aryabhattai* VPS1	Ground water As-contaminated paddy field	Unknown
	B. licheniformis VPS6		Biomineralization
	Sporosarcina thermotolerans VPS7		Biomineralization
Hg-resistant bacteria	88 bacterial isolates (characterized, based on Gram-staining patterns)	Surface water of different regions	Assessment of metal contamination

Acute effects of Ag2S NP in fluvial biofilms before and after ozonation process

Berta Bonet1, Bettina Wagner2, Flavio Picapietra2 and Renata Behra2
1School of Geography, Earth and Environmental Sciences, University of Birmingham (GEES-UoB). Birmingham. The United Kingdom. 2Swiss Federal Institute of Aquatic Science and Technology (Eawag), Department of Environmental Toxicology, Du¨bendorf, Switzerland
Presenter: Berta Bonet
Type of Presentation: Oral

Abstract
With increasing use of silver nanoparticles (Ag NP) their occurrence into wastewater is inevitable. Transformation and removal processes in wastewater treatment plants (WWTP) will determine the impact of Ag NP on aquatic systems. In sewers and WWTP sulfidized Ag NP are formed under anoxic conditions and in presence of sulfide, and represent the main transformation product in waste water effluents. Silver sulfide nanoparticles (Ag2S NP) display extreme low solubility and high resistance to oxidation in freshwaters. However, upon ozonation as applied in WWTP to degrade organic pollutants might also oxidise Ag2S NP leading to the release of toxic Ag+1 ions in water. Thus, the main aim of this study was to assess

the acute effect (after 2h) of Ag2S NP before and after ozonation on fluvial biofilms. We expected no effects of Ag2S NP but toxic effects after ozonation process. Biofilm was used as bioindicator since is a microbial community that plays a key role as primary producer in fluvial systems. Biofilm was obtained after 4 weeks of colonization in an indoor flow-through channels with glass slides in. It was used a natural inoculum from a small peri-urban stream. After colonization time, biofilm slides were scraped and placed in a buffer and was expose to different types of Ag2S NP. The two different types of Ag2S NP were: (i) one prepared by partial sulfidation of silver NP yielding particles with an elemental silver as a core and an Ag2S shell (Ag-Ag2S NP) and (ii) the other was obtained by precipitation of Ag+ and S2- (Ag2S NP). The size of both Ag2S NP was <100 nm and particles were not aggregated. Ag2S NP were ozonated in a borate buffer and chloride (Thalmann et al. 2016). Toxicity test was run with 5 different solutions. Before ozonation 10 and 100 µM of both types of Ag2S NP and after ozonation a range of concentrations (0, 0.05, 0.1, 0.25, 0.50, 0.75, 1, 2, 5 µM) of Ag2S NP and AgNO3 were used. Toxicity test was assessed using photosynthetic activity, respiration and extracellular ß-Glucosidase endpoints. As expected, before ozonation the total dissolved Ag in Ag2S NP suspensions was very low in exposure media (< 0.2% of total silver) confirming the low dissolution of these NP. No photosynthetic effects were observed. Nevertheless, it was observed a stimulation of biofilm respiration in both Ag2S NP types and concentrations and a reduction of ß-Glucosidase activity at 100 Ag-Ag2S NP µM. After ozonation of Ag2S NP the total dissolved Ag concentration increased up to 75% confirming an efficient Ag2S oxidation and according to our hypothesis, biofilm endpoints were affected. Photosynthetic activity of ozonated Ag2S NP and AgNO3 showed an EC50 around 2 µM. Meanwhile, respiration showed an AgNO3 EC50 < 0.4 µM meanwhile ozonated Ag2S NP stimulated the respiration. The upgrade of WWTP process, like ozonation, should be evaluated carefully in terms of benefits: if they are more positive rather than secondary effects such can be the availability of dissolved toxic ions in the freshwater systems.

Teresa Fernandes
TBC

Biogeochemical and hydrological constraints on concentration-discharge curves

F. Moatar, B. Abbott, C. Minaudo, F. Curie, G. Pinay
Université François-Rabelais de Tours
Presenter: Florentina Moatar
Type of Presentation: ORAL

Abstract

To investigate the prevalence and cause of concentration-discharge (C-Q) relationships for carbon, nutrients, major ions, and particulates, we analyzed 40 years of water quality data from 293 monitoring stations in France. Catchments drained diverse landscapes and ranged from 50 to 110,000 km2, together covering nearly half of France. To test for differences during low and high flows, we calculated independent C-Q slopes above and below the median discharge. We found that 84% of all catchment-element combinations were chemodynamic for at least half of the hydrograph and 60% of combinations showed nonlinear C-Q curves. Only two or three of the nine possible C-Q modalities were manifest for each parameter, and these modalities were stable through time, suggesting that intrinsic and extrinsic elemental properties (e.g.,solubility, reactivity, and source dynamics) set basic C-Q templates for each parameter, which are secondarily influenced by biological activity during low flows, and the interaction between hydrology and catchment characteristics at high flows. Several patterns challenged current C-Q views, including low-flow chemostasis for TSS in 66% of catchments, low-flow biological mediation of NO23 in 71% of catchments, and positive C-Q for dissolved organic carbon independent of catchment size in 80% of catchments. Efforts to reduce nutrient loading decreased phosphorus concentration and altered C-Q curves, but NO23 continued to increase.
While C-Q segmentation requires more data than a single analysis, the prevalence of nonlinear C-Q slopes demonstrates the potential information loss associated with linear or monotonic analysis of C-Q relationships, and conversely, the value of long-term monitoring.

S10 Novel sensing and monitoring techniques in hydroecology - from 'omics' to distributed sensor networks and real-time ecohydrology

Laurent Pfister

Water isotopes provide insights into the hydrologic functioning of sustainable drainage systems for stormwater management

Anne J. Jefferson

Kent State University
Presenter: Anne J. Jefferson
Type of Presentation: ORAL

Abstract
Increasingly popular, sustainable drainage systems (SuDS) or green infrastructure for stormwater management is touted as decreasing runoff volumes and improving water quality. These water quality improvements are attributed to filtration by flow through the green infrastructure's substrate and retention of water that allows plant uptake and biogeochemical processing to occur. Often, however, green infrastructure is treated as a "black box" and processes are inferred from inflow and outflow concentration data. Stable isotopes of the water molecule have the potential to shine a light into the black box, because they are an ideal tracer of ecohydrological processes occurring within the system. Here we explore insights to be gained by examining water isotopes for four forms of green infrastructure for which simultaneous flow and water quality data are available. Water isotopes were measured from bulk precipitation, inflow, outflow, and surface water storage.
In green infrastructure without ponded water storage (e.g., bioretention, green roof) evaporation is not detected in the isotopic signatures of outflow water, while green infrastructure with surface water storage (e.g., ponds and wetlands) frequently showed evaporative signatures. Coupled with soil moisture and water level data, the isotopic patterns provide qualitative information on the relative importance of evaporation and transpiration. In small, low intensity events, green infrastructure effectively smooths out short term fluctuations in precipitation isotopes. Under more intense rainfall, the dampening and lagging of isotopic variations from inflow to outflow appears to be a function of available storage in the surface or subsurface and the transit time of water through the system. Inter-event storage and release of old water is observed across a series of storms, for all forms of green infrastructure except the green roof. Isotopic hydrograph separation is possible for some events. Such isotopic insights also show promise for interpreting patterns of water chemistry within and across storms.

Development of a continental-scale database of streamflow and stream temperature for aquatic ecosystem studies

Darren Ficklin Jason Knouft

Indiana University
Presenter: Darren Ficklin

Type of Presentation: ORAL

Abstract
Freshwater systems are heavily impacted by human actions that result in detrimental effects on hydrology (i.e., altering seasonal streamflows) and water quality (i.e., increasing water temperatures), which are subsequently impacting freshwater biodiversity. Future changes in air temperature and precipitation are expected to further impact water resources and the biodiversity dependent on these systems, yet basic data describing variation in streamflow and water temperature across North America are not available. This presentation will discuss the development of the new "HydroClim" database that will provide historical and projected monthly streamflow and water temperature data for stream sections in all major watersheds across the United States and Canada from 1950-2099. This work will produce the first dataset on freshwater resources in North America of this scope and resolution. These data will also be integrated with FishNet 2 (www.fishnet2.net), a data portal that provides scientists, government agencies, resource managers, and the general public free and open access of over 2 million species locations of freshwater fishes for the United States and Canada, thus allowing for the characterization of the habitat requirements of freshwater species in this region. HydroClim will provide a vast array of benefits to the public in terms of greater understanding of water resources in the coming century as well as scientists focusing on the conservation of water resources and freshwater biodiversity in the United States and Canada.

Unpicking dissolved organic matter dynamics in an urban river system using time series analysis

K. Khamis, C. Bradley, D.M. Hannah & R. Stevens

University of Birmingham
Presenter: Kieran Khamis
Type of Presentation: ORAL

Abstract
Our understanding of dissolved organic matter (DOM) dynamics in urban river systems has been hampered by low resolution, manual sampling that often fails to characterise storm events adequately. Recent advances in optical sensing have made it possible to monitor both DOM quantity and quality by probing specific components of the DOM pool. More specifically, using in-situ fluorometers, we are able to measure Peak C (Ex. 365; Em. 490 nm) and Peak T (Ex 285 nm; Em 345 nm) that are strong surrogates for DOC and BOD respectively. Hence, we are now able to utilize more sophisticated methods for unpicking DOM dynamics, such as time series methods frequently used to describe the characteristics of hydrological time series. In this study, we undertake time-series analysis of a high resolution (hourly resolution) DOM and hydro-climatological data set collected from a headwater urban stream (Bournbrook, Birmingham, U.K). During 2015 (April – Dec) Peak C, Peak T and turbidity were determined using a through-flow, fluorescence sensor

(GGNU-FL30). Ancillary measurements of electrical conductivity (EC), water temperature and stage (converted to discharge) were also collected. Metrological variables were recorded at an automatic weather station on the University of Birmingham campus (1.5 km from the study site). Peak C displayed a strong seasonal trend with higher base flow fluorescence readings recorded during the autumn month while Peak T base flow readings were consistent through the year. The flow regime was extremely responsive to precipitation with lag times of <3 hrs and storm events occurred throughout the monitoring period. Both Peak C and Peak T fluorescence increased during high flow events, with the greatest magnitude increases in fluorescence associated with events flowing periods of low antecedent precipitation. In addition a strong diurnal signal in Peak C fluorescence was detected during spring/ summer which was correlated with the short wave radiation flux, suggesting that even in this relatively fast flowing, headwater stream photodegradation of aromatic DOM is important. Following de-trending of the time series discharge was identified as the best predictor of both Peak C and T fluorescence intensity However, cross-correlation revealed Peak T intensity was generally associated with the rising while Peak C intensity followed discharge through the recession curve. This suggests it may be possible to fingerprint and track DOM associated with 'fast' and 'slow' flow paths in urban catchments. This analysis highlights the potential of using time series analysis to unpick patterns in high frequency, in-situ fluorescence records. Further, the work enhances our understanding of urban water quality dynamics, and specifically the importance of water residence time and routing through urban catchments.

Quantification of biogeochemical activity in streams using continuous monitoring of dissolved gases

Camille Vautier(1), Eliot Chatton(1), Benjamin W. Abbott(2)(3), Astrid Harjung(4), Thierry Labasque(1), Aurélie Guillou(1), Alexandrine Pannard(3), Christophe Piscart(3), Anniet Laverman(3), Tamara Kolbe(1), Stéphanie Massé(1), Jean-Raynald de Dreuzy(1),
Zahra Thomas(5), Luc Aquilina(1),Gilles Pinay(3)

Université de Rennes-1
Presenter: Camille Vautier
Type of Presentation: POSTER

Abstract

Stream water chemistry is the integration of biogeochemical processes occurring in contributing hydrological compartments (hyporheic and riparian zones, soils, aquifers) and in the stream network itself. This leads to complex concentration signals in rivers, fluctuating in space and time. Using dissolved gases as tracers for biochemical activity and transport processes, we quantified the relative impact of in-stream reactions and inputs from other hydrological compartments on river chemistry in two headwater streams located in Brittany, France. We performed stream-scale, factorial injections of inorganic nitrogen (NH4, NO3), inorganic

phosphorus (P2O5) and multiple sources of labile carbon (acetate, tryptophan) after 24 hours of monitoring to characterize baseline activity. Salt and helium were injected simultaneously and served as non-reactive tracers to quantify transport and degassing processes. We implemented a new field application of membrane inlet mass spectrometry to continuously monitored dissolved gases 100 meters downstream of the injection points along with wet chemistry and radon analysis. In order to characterize the baseline activity, the monitoring was started 24 hours before the first injection. Quantified gases included He, O2, CO2, CH4, N2 and N20. We calibrated and assessed the methodology with well-established complementary techniques including gas chromatography on grab samples and high-frequency water quality sensors. In addition, the activities quantified at the reach scale were compared to laboratory experiments carried out with sampled stream sediment. From a methodological perspective, the analyses demonstrated that high frequency variations linked to background noise can be efficiently determined and filtered to derive effective fluxes. Thus, this innovative technology allows fully-controlled in-situ experiments providing rich information with a high signal to noise ratio. From a more ecological perspective, this approach allowed us to not only quantify nutrient demand and spiraling length, but also determine the type of metabolism responsible for these kinetics (e.g. aerobic respiration, methanogenesis, denitrification) at the reach and catchment scale.

Data Integration - Hydrology, Water Quality and Biological Observations

Dr. Frank Schlaeger

KISTERS AG (private sector)
Presenter: Dr Frank Schlaeger
Type of Presentation: ORAL

Abstract

Many current water quality and biological sampling data analyses and assessments are based on in-situ data. An exciting future prospect for better managing this data is that assessments will now benefit from integrating with other sources of data including location based observations in a more reliable and operational manner (WMO-Nr. 1113, 2013). According to Hirsch et.al., (2006) the priorities to meet future needs for water quality management and assessment are: • Understanding the relations between water quality conditions and the natural landscape, hydrological processes, the subsurface and the human activities that take place on the landscape within watersheds. • Evaluation of water quality in concert with water quantity and biological systems. • Monitoring over long time scales and placing measurements in a historical, hydrological context. Environmental agencies around the world often manage data in different locations and formats which reduce the data's utility. The challenge for agencies is to provide solutions for data consumers and stakeholders to have one unified view of the data thus improving data access and the utility for making better decisions. A new water information system was developed as a single solution for managing any environmental data that allows users to assess their data in one location for an overall "total resource"

context. A system for managing, validating and calculating long term and continuously measured hydrological and environmental time series data is in place in UK since more than ten years. In order to manage chemical-physical sample results and ecological observations (from invertebrates to fish catches, from sediment analysis to habitat surveys) the existing system was considerably enhanced. The extended system now offers a solution for integrating all data sources to improve the management and assessment of chemical-physical data as well as biological data. The new system enables users to manage sampling data, which requires different data handling because of the magnitude of sampling parameters. In addition, it provides the necessary data management tools for handling biological observations by introducing a time dynamic taxonomic tree and GIS capabilities to store observations against any geographical elements as points, transects or polygons. This paper will focus on the Natural Resources Wales (NRW) project where hydrological, water quality and biological data was integrated into a single system. The efforts for data integration and its benefits will be highlighted.

Detecting the invisible water drain: forest evaporation with Distributed Temperature Sensing (DTS)

A.M.J. Coenders-Gerrits 1) B. Schilperoort 1) W.M.J. Luxemburg 1) C.D. Jiménez-Rodriguez 1) C.R. Cisneros Vaca 2) M. Ucer 2)

Delft University of Technology
Presenter: Dr Miriam Coenders-Gerrits
Type of Presentation: ORAL

Abstract
Worldwide 55-80% of the rainfall annually evaporates from the land, making it the largest outgoing flux in the water balance and therefore measuring of the flux is of utmost importance for flood and drought forecasting, weather predictions, and to determine the irrigation demand, which is especially for water scarce areas of vital importance. Due to technical difficulties and high observational costs, knowledge on evaporation is surprisingly limited. Recently we developed a new method (based on the Bowen ratio) that not only quantifies evaporation, but also provides more insight in the behaviour of heat fluxes within forests. By using temperature dependent fibre optic cables (DTS) we can measure with one single sensor vertical temperature and humidity gradients. The latter is obtained by wetting a stretch of the cable to get the so-called 'wet-bulb temperature'. We tested the DTS-setup in a tall mixed forest in the centre of The Netherlands and compared the results to conventional temperature and humidity sensors and an Eddy Covariance system, which both gave good results. Since the setup does not only measures gradients above the canopy, but also inside and underneath the canopy, we can also use DTS to partition evaporation into transpiration and soil evaporation. Furthermore, by looking at the temporal temperature variations over the height, we can also learn more about the heat storage and flux terms inside forests. This information can be

used to improve remotely sensed evaporation algorithms that lack information on how remotely sensed top canopy temperature relates to surface temperature, which is important for land-atmosphere modelling.

Monitoring Water Quality on a Continuous Basis: how good are the new sensors?

François Birgand, Chiao-Wen Lin, Elizabeth Allen, Randall Etheridge

NC State University
Presentor: François Birgand
Type of Presentation: ORAL

Abstract
A revolution in the way we measure, understand, and predict the fate and transport of C, N, and P in streams and rivers is made possible with the availability of new continuous water quality sensors. For the first time in history of hydrological sciences, there is the possibility to capture the changes in parameter concentrations for all events, in particular the large and extreme ones which weigh so heavily in the total exports. While these sensors provide unprecedented insight on the dynamics of water quality dynamics (e.g., diel concentration fluctuations, concentration increase/decrease during events), it is important to know the uncertainty associated with these instruments. In particular, mass balance and stoichiometry are crucial to understand and quantify the fate of C, N, and P. We report here the uncertainty that may be expected on annual loads of Nitrate, Organic Nitrogen, Dissolved Organic Carbon, Total Phosphorus, and Total Suspended Solids, due to sensor uncertainty in coastal plain watersheds of North Carolina. For this, we tested the impact of the stratification and number of discrete samples to calibrate UV-Vis spectrophotometers from S::CAN for three watersheds. We compare the uncertainty calculated on the annual loads to those induced by infrequent sampling.

Can a riparian vegetation model be spatially validated?

Alicia García-Arias (1) Joaquín Segarra (1) Félix Francés (1)

Universitat Politècnica de Valencia - Research Institute of Water and Environmental Engineering
Presenter: Dr Alicia García-Arias
Type of Presentation: ORAL

Abstract
The RVDM (Riparian Vegetation Dynamic Model) is a novel ecohydrological approach that has demonstrated great capabilities for the riparian vegetation prediction in natural semiarid systems (García-Arias and Francés, 2016). This

contribution aims to demonstrate the versatility of the model in the prediction of the plant distribution in a different riparian environment, in which the flow regulation modifies the typical seasonality of natural floods and droughts impacts characteristic of semiarid environments. The model has demonstrated to be sensitive to a regulated regime, predicting correctly the dynamic behaviour of different succession phases and lines in the plant community. In terms of correctly classified instances, the modelling accuracy resulted between 0.6 and 0.9. The kappa coefficient of agreement, which estimates the model performance neglecting the agreement randomly achieved, resulted on values between 0.5 and 0.8 in the different temporal case studies analysed. Spatially, the model predicted correctly the transversal distribution of the observed riparian communities. These results are comparable, even better, to those obtained during the model calibration in a natural semiarid river system (García-Arias and Francés, 2016) in which the sensitivity analysis of RVDM revealed the importance of natural floods in the vegetation dynamics simulation. Therefore, the main conclusion extracted from this research is the spatial robustness of the model, which is capable to predict plant behaviour under different hydrological regimes in a river different to the calibration one.

A conceptual model of groundwater dissolved organic nitrogen based on a machine learning method and sensitivity analysis

Benya Wang, Matthew R. Hipsey, Carolyn Oldham

The University of Western Australia
Presenter: BENYA WANG
Type of Presentation: ORAL

Abstract
Groundwater nutrient studies have historically focused on the ecological effect of dissolved inorganic nitrogen (DIN) and its management; however, several groundwater investigations have identified dissolved organic nitrogen (DON) as the dominant form of total dissolved nitrogen (TDN) in their study areas. The groundwater DON is readily transported to the surface water system and contributes to the deterioration of surface water quality in sandy areas with shallow groundwater which have strong surface-groundwater interactions. Despite the ecological importance of groundwater DON, there is a paucity of information about the sources and cycling processes of groundwater DON. A detailed groundwater DON investigation was carried out on the Swan Coastal Plain (SCP) in Western Australia to fill these knowledge gaps. Our results indicated a decreasing spatial gradient of groundwater DON concentrations and DON/TDN ratios from the inland scarp to the Indian Ocean, which is also in line with the overall groundwater direction. Clear long-term increases in groundwater DON concentrations and DON/TDN ratios were also found from our results. A machine learning method (random forest) and two kinds of sensitivity analysis were applied in this study to classify groundwater DON into low, medium, and high classes and to further explore the ecohydrological conditions controlling groundwater DON. The model achieved

73% and 80% classification accuracy for groundwater DON concentrations and DON/TDN ratios, respectively. Groundwater subareas and groundwater dissolved organic carbon (DOC) concentrations were observed as the most important variables for groundwater DON concentration prediction, followed by sampling conditions (sampling month, sampling date and sampling depth). Unlike traditional assumptions about the effects of urbanization on water quality, land use, vegetation, and soil type were first ranked as the lesser important variables for both groundwater DON concentration and DON/TDN ratio predictions on SCP. However, the results of the sensitivity analysis suggested that they strongly interact with groundwater DOC and sampling depth to impact the DON concentrations, and interact with groundwater to affect DON/TDN ratios. According to these results, we put forward a new conceptual model of groundwater DON for sandy shallow groundwater systems. The highly permeable sandy soils provide a hydrological interface to connect the surface landscapes and shallow groundwater systems. During the infiltration of surface waters through the sandy soils, the surface landscape characteristics are integrated, thus removing distinctive signatures. In areas with shallow groundwater water, the infiltration travel time is shorter, and therefore signatures of surface landscape characteristics remain. The threshold depth for groundwater to preserve surface characteristics remain unknown and require further investigation. In summary, our results seem to suggest that the traditional assumptions about the effect of urbanization on groundwater DON may not always hold in sandy shallow groundwater areas. An alternative conceptual model of groundwater DON is proposed which may be suitable for other sandy shallow groundwater areas.

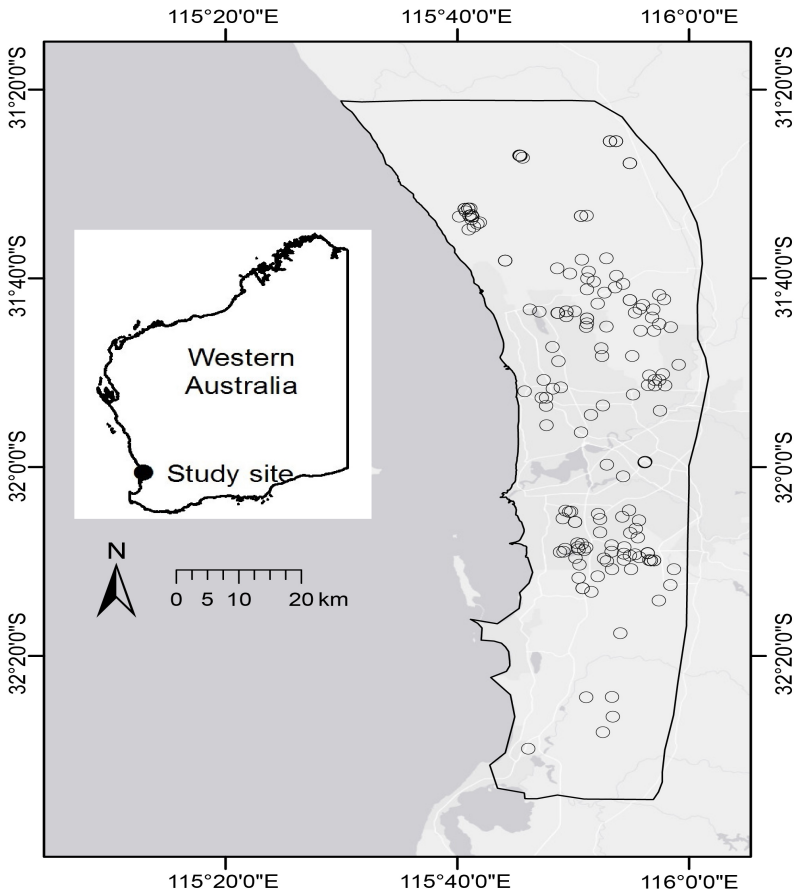


Figure 1. The location of Swan coastal plain (black outline) and sampling groundwater wells (the hollow circles)

Characterising river temperature heterogeneity using UAV-based thermal infrared remote sensing and deterministic river temperature models

Stephen J Dugdale, David M Hannah, Iain A Malcolm

University of Birmingham, School of Geography, Earth and Environmental Sciences
Presenter: Stephen Dugdale
Type of Presentation: ORAL

Abstract

Climate change will increase summer water temperatures in northern latitude rivers. It is likely that this will have a negative impact on fish species such as salmonids, which are sensitive to elevated temperatures. However, some rivers contain mosaics of warm and cool habitats which allow ecosystems in these environments increased resilience to climate change. Rivers with high thermal

habitat heterogeneity will therefore be increasingly important in sustaining fluvial biodiversity in the face of climate change, and a better understanding of river temperature heterogeneity is key for developing climate change adaptation strategies. Although previous research using airborne thermal infrared (TIR) imagery has highlighted the high degree to which river temperature heterogeneity varies geographically, conventional remote sensing and modelling approaches have proven sub-optimal for the characterisation of river temperature heterogeneity simultaneously across both the spatial and temporal domains. There therefore remains a general lack of information about the processes driving river temperature heterogeneity and how these space-time patterns might vary under future environmental change. However, recent advances in UAV technology present a potential solution to this problem. Using UAV-based TIR imagery, it is now possible to quantify river temperature heterogeneity across multiple spatial scales and at sub-daily timesteps. When combined with deterministic river temperature models, this allows for an unprecedented insight into the processes responsible for space-time patterns of river temperature heterogeneity. The paper presents a new project aiming to use these complementary approaches to understand river temperature heterogeneity across key UK rivers. First, we review previous research on TIR remote sensing applied to the quantification of river temperature heterogeneity. We then report preliminary results from data acquisition flights using a TIR-equipped UAV, demonstrating its capacity to visualise variability in river temperature heterogeneity at multiple spatio-temporal scales. Finally, we discuss how these technological advances will help to improve current and future strategies for protecting river ecosystems from the impacts of climate change. Suggested session: S10: Novel sensing and monitoring techniques in hydroecology - from 'omics' to distributed sensor networks and real-time ecohydrology.

Application of a New Point Measurement Device to Quantify Groundwater-Surface Water Interactions at the Interface

Mackenzie Cremeans[1], Rick Devlin[1], Ursula McKnight[2], Poul Bjerg[2]
[1] University of Kansas, Department of Geology
[2] Technical University of Denmark, Department of Environmental Engineering

Presenter: Mackenzie Cremeans,

Type of Presentation: Oral

The StreamBed Point Velocity Probe (SBPVP), a new point measurement device, measures *in situ* groundwater velocities at the groundwater-surface water interface (GWSWI) without reliance on estimations of hydraulic conductivity (K), porosity (n), or gradient information. After validation in laboratory studies, the SBPVP was applied to a meander of the *Grindsted Å* to determine patterns of groundwater-surface water exchange (GWSWE). SBPVP data were compared with similarly scaled temperature gradient and hydraulic head data. Results from the SBPVP were in good relative agreement with the

exchange patterns suggested by temperature gradient data and came within ±23% of the absolute velocity values suggested by the hydraulic head data. These agreements suggest the SBPVP yields accurate velocity data, with the added advantages of being a faster absolute measurement method with fewer potential sources of error than the other methods in this study. Analysis of the spatial distribution of velocity values suggests exchange patterns in the *Grindsted Å* are highly heterogeneous. These patterns were combined with geochemical data to determine the mass discharge of specific solutes (PCE, TCE, cis-DCE, and VC). Mass discharge was found to be concentrated in "hot spots" controlled in location, extent, and magnitude by concentration and velocity distributions. Therefore, detailed information about flow at the GWSWI is vital to understanding solute, and, by extension, nutrient, movement in ecosystems affected by exchange.

S11 Forest Ecohydrology
Philip Blaen

Governing forestry effects on mercury - Who owns the problem?

Kevin Bishop Karin Eklöf, Rolf Lidskog, Camilla Sandström, Staffan Åkerblom, Eva Ring

Swedish University of Agricultural Sciences, Dept. of Aquatic Sciences and Assessment
Presenter: Kevin Bishop
Type of Presentation: ORAL

Abstract
Fish Hg concentrations well above the Environmental quality standard set by the water framework directive (0.02 mg g-1 ww) are a major concern in large parts of Fennoscandia. Apart from anthropogenic Hg emissions to the atmosphere that deposits to forests far from the source of emissions there are catchment and lake characteristics that make Hg biomagnify effectively in aquatic food chains. Forestry operations can mobilize Hg from the soil, increasing Hg concentrations and loads in surface waters. Forestry activities might also cause waterlogged soils that make good habitats for Hg methylating microorganisms, increasing the formation of bioavailable methylmercury (MeHg). However, available forestry effect studies reveal considerable variation in treatment effects on MeHg at different sites, varying from no effect up to manifold concentration increases. Also, most available forestry effect studies focus on MeHg in low-order streams. When evaluating the effect of forestry on fish Hg concentrations it adds several layers of uncertainty associated with bioaccumulation. For management practices, it is hard to find solutions when the knowledge about different management strategies is complex. Hg is not originally delivered by forestry itself, but from other human activities as well as natural sources. The forestry sector nevertheless has a responsibility to minimize the negative impact of harvest operations on the forest´s capacity to buffer and mitigate the pollution originating from other sectors. The issue of climate change has put additional demands on the forests to provide biomass as a substitute for fossil fuel. Thus, decision-makers are facing a "wicked problem": How to reduce forestry's impact on Hg in aquatic ecosystems while securing other ecosystem services across the entire forestry cycle. In order to explore forestry's responsibility and possible solutions to this problem in Sweden, a transdisciplinary approach has been used where actors from relevant governmental agencies, forest companies and forest associations have been involved. Through structured dialogue based in a risk governance approach, the character of the problem and possible ways to handled it were explored. The analysis shows that there are ways to handle the issue, but the complex character of the problem makes a need to include not only management practices for forestry but also the need to discuss regulatory goals and environmental objectives. The Hg-problem represents a class of difficult issues for forestry where the direct impact of forestry needs to be weighed against the contribution which that regulation can have on the overall issue.

Riparian Landscape Fragmentation, Reforestation Efforts, and the Regulation of Headwater Stream Network Thermal Regimes

Valerie Ouellet Melinda Daniels

Stroud Water Research Center
Presenter: Dr Valerie Ouellet
Type of Presentation: ORAL

Abstract

Many studies have shown the stabilizing and cooling effects of riparian buffers on daily maximum temperature and water temperature dynamics. Few studies have detailed exactly which processes control the cooling and warming of stream water, the thermal buffering efficiency of the riparian buffer, and how quickly (rate and gradient) the changes happen as streams transit often fragmented riparian forest landscape segments. Understanding how riparian forest fragmentation affects stream thermal regimes is essential to informing stream temperature models as well as effective land management programs that aim to restore or protect the quality and longitudinal spatial extent of riparian buffer needed to achieve thermal restoration and/or resilience in the face of projected climate warming. Successful modeling and management of temperature regimes is essential to ensure the diversity of thermal habitats needed for the conservation of thermally sensitive fish species, such as the brook trout (Salvelinus fontinalis), a species that has been in decline for many decades in the Mid-Atlantic region of the United States. Here we present the results from a landscape-level study to evaluate the effects of riparian forest buffer quality (height, stand density, thickness), age on the thermal regimes of headwater streams flowing through riparian land use mosaics of agriculture and forest. The results showed that from April and throughout the rest of the summer, different patterns appeared between mosaic fragments, and these differences increased progressively during summer, with the unforested reaches being warmer. Across riparian mosaic type, differences in the mean daily water temperature varied up to 4.2oC, and diurnal variations ranged widely. Restored riparian buffer patches, even those with several decades of growth still displayed significantly warmer thermal regimes than mature forest patches. Analysis of adjacent riparian patches revealed very rapid warming of stream water flowing from covered to exposed patch cover types. A more detailed investigation of within-reach pool thermal regimes also paralleled the landscape-level patch findings. The fragmented riparian landscape strongly controls stream network water temperature dynamics. This represents a challenge for stream network thermal modeling, restoration efforts and conservation of thermally sensitive species for example. Our results show clearly the thermal benefits of forested stream buffers, but this is among the first studies to quantitatively evaluate how riparian landscape fragmentation affects network-scale patterns of temperature. Conservation and restoration efforts should focus on protecting, improving and connecting riparian forest buffers.

Forests, Fish and Freshwater Pearl Mussels – Ongoing Research at the Hydrology-Ecology Interface

Nadeem W. Shah Thomas R. Nisbet

Forest Research
Presenter: Nadeem Shah
Type of Presentation: ORAL

Abstract

Many of Britain's forests are planted in environmentally sensitive catchments supporting protected species such as Atlantic salmon and the freshwater pearl mussel. When the forests were first established, the hydroecological effects of forest management were generally not considered, including in wetter upland areas where extensive drainage was needed to establish trees. Large scale afforestation led to a number of pressures on the water environment including sediment and nutrient delivery following cultivation and drainage operations, nutrient enrichment from fertilisation, changes to water flows and resources, and acidification due the increased capture of acid deposition by the growing forest canopy. Forest management has greatly advanced in recent years and protecting water quality and ecology is now a key objective of forest management plans. This is translated into practice in a number of ways including open habitat restoration (e.g. forest to bog), the implementation of good management practices (e.g. the Water Guidelines) and the restoration of riparian woodlands to buffer the water environment (e.g. by retaining diffuse pollutants, providing shade and slowing flood flows). Monitoring is being undertaken to understand the effects of these developments on the water environment and to inform further improvements to management guidance. This paper presents an overview of a number of research experiments at the hydrology-ecology interface. Firstly, we present results from a study investigating the effects of lowland raised bog restoration on drainage water chemistry; the study was driven by concerns over the effects of large scale felling on peatland on the freshwater pearl mussel, a critically endangered species that is threatened throughout its holarctic range. We then describe results from a study being conducted in the Highlands of Scotland investigating the effects of aerial fertilisation on water quality in catchments that are designated Special Areas of Conservation (SAC) for freshwater pearl mussel and Atlantic salmon. We finish by introducing our research on large scale peatland restoration of blanket peatlands including sites in the flow country, the largest expanse of blanket peat in Europe; here we are working with multiple stakeholders, including the Scottish Environmental Protection Agency (SEPA), the Royal Society for the Protection of Birds (RSPB) and Forestry Commission Scotland, to monitor the effects of restoration on this Special Area of Conservation.

Forest transpiration: Resolving root water uptake patterns in space and time

Theresa Blume, Ingo Heidbüchel, Sonia Simard, Andreas Güntner, Markus Weiler, Ryan Stewart

GFZ German Research Centre for Geosciences
Presenter: Dr Theresa Blume
Type of Presentation: ORAL

Abstract
Transpiration and its spatio-temporal variability are still not fully understood, despite their importance for the global water cycle. This is in part due to our inability to measure transpiration comprehensively. Transpiration is usually either estimated with empirical equations based on climatic variables and crop factors, by measuring sap velocities, estimating sap wood area and scaling up to the forest stand based on a number of assumptions or by measuring the integral signal across a footprint with eddy flux towers. All these methods are focused on the total loss of water to the atmosphere and do not provide information on where this water is coming from. In this study, spatio-temporal variability of root water uptake was investigated in a forest in the northeastern German lowlands. We estimated root water uptake from different soil depths (10-200 cm) based on diurnal fluctuations in soil moisture content on rain-free days. We used the physically-based soil hydrological model HYDRUS to test assumptions and estimate uncertainties of this soil moisture based estimation of plant water uptake. The 14 field sites cover different topographic positions and forest stands: mature and young beech and pine stands, mixed oak/beech and pine/beech stands. The resulting daily data set of root water uptake shows that the forest stands differ in total amounts as well as in uptake depth distributions. Temporal dynamics of signal strength within the profile suggest that spatial distribution of uptake changes with water availability. The resulting unique data set of depth-specific contributions to root water uptake allows for a much more detailed analysis of forest response to water availability than the more common transpiration estimates generated by sapflow or eddy flux measurements, and therefore has the potential to improve models of the soil-plant-atmosphere continuum.

A global review on hydrological responses to forest change across multiple spatial scales

Mingfang Zhang1, Dingyuan Ning1, Yiping Hou1, Shirong Liu2

University of Electronic Science and Technology of China
Presenter: Dr Mingfang Zhang
Type of Presentation: ORAL

Abstract
Despite extensive studies on hydrological responses to forest cover change in small watersheds, the hydrological responses to forest change and associated mechanisms across multiple spatial scales have not been fully understood. This review thus examined about 312 watersheds worldwide to provide a generalized framework to evaluate hydrological responses to forest cover change and to identify the contribution of spatial scale, climate, forest type and hydrological regime in

determining the intensity of forest change related hydrological responses in small (<1000 km2) and large watersheds (=1000 km2). Key findings include: 1) the increase in annual runoff associated with forest cover loss is statistically significant at multiple spatial scales whereas the effect of forest cover gain is statistically inconsistent; 2) the sensitivity of annual runoff to forest cover change tends to attenuate as watershed size increases only in large watersheds; 3) annual runoff is more sensitive to forest cover change in water-limited watersheds than in energy-limited watersheds across all spatial scales; and 4) small mixed forest-dominated watersheds or large snow-dominated watersheds are more hydrologically resilient to forest cover change. These findings improve the understanding of hydrological response to forest cover change at different spatial scales and provide a scientific underpinning to future watershed management in the context of climate change and increasing anthropogenic disturbances.

S12 Hydroecological process dynamics and nutrient flows in wetlands and riparian zones

Sami Ullah, Nick Ketteridge, Thomas Hein

Large-scale nutrient retention, loading and management effects over whole wetlandscapes

Georgia Destouni

Stockholm University
Presentor: Georgia Destouni
Type of Presentation: ORAL

Abstract

In addition to individual wetland studies, investigation is also needed of the large-scale functioning of hydrologically coupled systems of multiple wetlands, which may be referred to as whole wetlandscapes. A survey of 21,433 scientific articles in the wetland literature shows that research attention so far has mostly focused on individual wetlands (80% of surveyed published papers) rather than on the large-scale functioning of whole wetlandscapes (Thorslund et al., in review, 2017). With regard to nutrient retention, both general theoretical and site-specific data analysis shows that large-scale retention over whole wetlandscapes may be insignificant even though retention in individual wetlands may be considerable (Quin et al., Ambio, 2015). The reason for such scale discrepancy is runoff-related, specifically if only a small fraction of the total runoff, and thus also of the waterborne transport of nutrients, goes through the individual wetlands of a whole wetlandscape. Statistically, this is indicated to be the case over two main water management districts of Sweden (Quin et al., Ambio, 2015). However, the available monitoring basis for possible mechanistic determination of large-scale nutrient transport and retention over whole wetlandscapes is small, covering only around 1% (down to 0.2% for nutrient loads) of the Swedish surface water bodies. Such limited monitoring of large-scale wetlandscape behavior is in agreement with the results of the general literature survey, showing the focus of most published studies to be on individual wetlands rather than on wetlandscapes (Thorslund et al., in review, 2017). For the first management cycle 2009-2015 of the EU Water Framework Directive (WFD), the nutrient data that are available over the whole wetlandscape region of Sweden indicate that management measures so far have led to only slight changes in measured nutrient concentrations, with moderate-to-bad status waters even exhibiting mostly concentration increases. These management effects are in direct contrast to the WFD management goals of: ecosystem status improvement to at least good level in all waters, and no status deterioration in any water body. Statistical correlations found in the available monitoring data indicate that such management failure may be due to the WFD-required ecosystem-status classification procedure not properly identifying main human-driven nutrient input and transport components, and/or main natural retention components over a whole wetlandscape. The classified ecosystem status is instead highly correlated to and thus appears dominated by the hydro-climatically (runoff) driven component of

nutrient loading through the wetlandscape. As a consequence, chosen nutrient management measures may then not be well suited for efficient mitigation of the human-driven inputs, concentrations and loads of nutrients over large wetlandscape scales.

Effects of increased atmospheric reactive nitrogen deposition upon rates of biological nitrogen fixation in peatbogs

Ernesto Saiz Val(1), Falko Drijhourt(1), and Sami Ullah(2)
Keele University
Presenter: Mr Ernesto Saiz Val
Type of Presentation: ORAL

Abstract
Ombrotrophic peatbogs depend on biological nitrogen fixation (BNF) for nitrogen nutrition. However, high levels of atmospheric reactive nitrogen (Nr) deposition poses a threat to these environments and evidence suggests that it can lower or even shut down BNF activity because Nr availability is no longer a rarity. To test this hypothesis, BNF rates where measured in three peatbogs with different Nr deposition rates, two British peatbogs: Migneint in Wales (~15 kg N ha-1 yr-1) and Fenn's and Whixall in England (>25 kg N ha-1 yr-1). The acetylene reduction assay (ARA) method was used for the measurement of BNF in 2016. To determine the conversion factor of ARA to BNF the 15N2 was used as well at these sites. Incubations for BNF using ARA and 15N2 methods focused on chunky and non-chunky mosses (non-chunky: Sphagnum cuspidatum, S. capillifolium, S. fallax; and chunky: S. magellanicum, and S. papillosum) as well as top bulk peat (0-15 cm) under hollows and hummocks. In Sweden, only the 15N2 method was used to measure the BNF rates in five mosses (non-chunky: S. fuscum, S. majus, S. balticum, and S. capillifolium; chunky: S. papillosum) and top bulk peat. Relevant variables that regulate BNF such as temperature, photosynthetically active radiation (PAR), pH, electrical conductivity, dissolved oxygen (DO), C:N, and soil moisture were measured as well. In Britain, BNF rates were higher in the warm season, and in the non-chunky species such as S. cuspidatum, S. capillifolium, and S. fallax. There was a significant difference in BNF rates between sites ($p<0.05$). The Swedish site fixed six times higher N2 than the British peatlands overall. Across the sites, BNF correlated negatively with the C:N ratio, suggesting that total N saturation in peatlands and moss species due to Nr deposition is supressing BNF. Significant correlations between BNF rates and temperature and electrical conductivity ($p<0.05$) was observed, suggesting a strong seasonal pattern of BNF. Based on the ARA and 15N2 methods, the conversion factor is lower than the reported 3:1 ratio of ethylene production to N2 fixation; however, a more robust correlation between ARA and 15N2 methods was not observed. Further research is underway to fully elucidate the controls of BNF in peatlands in Britain and the implication of Nr deposition.

An evaluation of spatio-temporal CO2 flux gradients across the soil-pond profile in an upland Irish blanket peatland

Mariya Radomski, Alan Gilmer, Vivienne Byers

DIT
Presenter: Mrs Mariya Radomski
Type of Presentation: ORAL

Abstract

Keywords: dissolved carbon dioxide, Irish blanket peatlands, climate control strategy, continuous in situ monitoring. The spatial extent, larger carbon store and sensitivity of Irish upland blanket peatlands to changes in the climate system make them an important land-use in determining Ireland's overall greenhouse gas emissions. Understanding the response of these biomes, monitoring their climate forcing potential and mapping their inherent climatic-biotic inertia represent key inputs to the development of a climate control strategy. In this respect it is necessary to take account of peatland soil-aquatic flux rates and eco-hydrological dynamics. The global fluvial fluxes of carbon are significant, approximately 34-46% of all fluxes of carbon. These fluxes are especially significant in peatland dominated catchments where run-off is high. Yet the dynamics of carbon dioxide in the upland blanket peatland dominated catchments in Ireland are not fully understood. It is well known that lentic systems, such as upland perennial ponds are supersaturated with carbon dioxide in comparison with the atmosphere. However, gas and mass movement within the peatland-pond continuum show high uncertainties both spatially and temporarily. This is particularly true of blanket peatland drainage systems where complex hydrological connectivity between ponds and the peatland soil leads to significant variability in flux values. The migration of carbon dioxide from the peatland ponds driven by concentration gradients has not been established nor quantified in Irish blanket peatlands. This gap in system knowledge presents a barrier to effective carbon management on a regional or national scale and has consequences for the development of appropriate carbon-water quality management practices. This paper sets out the results of a series of 'Peat-Hydro' monitoring stations in the upland blanket peatlands of County Wicklow, Ireland. A series of pond-based and peat soil-based non-dispersive infrared sensors enclosed in a water impermeable and gas permeable polytetrafluoroethylene membrane were installed at strategic locations along the riparian-pond continuum. The pond-based sensors float at a constant water level and are kept in a protective housing apparatus. Riparian sensors are kept in dip-wells and are also floating at the level of the water table. These sensors provide a continuous, in situ record of dissolved carbon dioxide concentrations. These outputs will aid understanding of the temporal and spatial dynamics and controlling factors of carbon dioxide transport in blanket peatland dominated catchments. These findings also have a direct bearing on approaches to carbon inventory assessment, climate change strategy, water quality management and will feed into future research in the area of peatland carbon cycling and land management practices.

Numerical Simulation of Surface water and Groundwater Interaction in the Wetlands

Schradh Saenton

Department of Geological Sciences, Faculty of Science, Chiang Mai University
Presenter: Schradh Saenton
Type of Presentation: ORAL

Abstract
This study presents the use of numerical groundwater flow modeling to assess the interaction between shallow coastal groundwater aquifer and the overlying mangrove wetlands in Eastern coast Thailand. Specific goal was set to quantitatively evaluate the seasonally varying discharge and/or recharge rates between surface water and groundwater. A three-dimensional, finite-difference groundwater flow model, MODFLOW, that is capable of simulating the exchange of water between surface water body and groundwater aquifers, was used to achieve this goal. The model was calibrated using observed hydraulic heads in observation wells based on a universal inverse modeling algorithm called PEST. It was found that, in the study area, the discharge of fresh to slightly brackish groundwater to mangrove wetlands varied seasonally. This discharge was then mixed with seawater to produce sub-salinity level (as compared to inlet seawater) allowing coastal macro-invertebrates as well as mangrove species to survive and maintaining biodiversity of the area.

Coupling hydrology and biogeochemistry in riparian wetlands: An interdisciplinary approach

Stefan Durejka, Sven Frei, Benjamin Gilfedder

University of Bayreuth, Department of Hydrology
Presenter: Stefan Durejka
Type of Presentation: ORAL

Abstract
The hydrological and biogeochemical responses and dynamics of riparian wetlands play a critical role in the global cycling of Carbon C through the exchange of CO2 with the atmosphere, the emission of CH4, the production and export of dissolved organic carbon (DOC) and the storage of C. The interactions between hydrology and biogeochemistry are important control mechanisms for wetland ecosystem function and the services they provide. Convoluted positive and negative feedbacks make it difficult to assess the future response of riparian wetlands and how they will adjust to external forces e.g. climate change. The complex coupling between hydrology and biogeochemistry together with the consequent potential influence on biogeochemical hot-spot development, solute transformation and mobilization processes is only poorly understood. We aim at an integrated understanding of complex riparian wetlands processes and their links to easily accessible

hydrological metrics such as water table depth. New robust and autonomous methods can be used in further studies especially in remote locations. Thus, in this work we combine novel methods of high temporal resolution measurements of Rn-222 with continuous monitoring of DOC and complementing hydrological and hydrogeological observations. The objective is to understand how short term changes in hydrology (e.g. daily cycles, storm events) lead to preferential mobilisation and internal cycling (hot-spot generation) of biogeochemically active ions and molecules. First results indicate an inverse diurnal cycle of Rn-222 and DOC in the Mid-August outflow of a riparian wetland site located within the Fichtelgebirge mountains in northern Bavaria, Germany. Rn-222 concentrations fluctuate by approx. 300 Bqm-3 between a minimum shortly after sunrise and a maximum in the late afternoon. These extremes correspond to a maximum and minimum in DOC concentration and water level elevation, respectively. DOC concentration varies around 2 mgL-1 and water level elevation around 1 cm. A fast response of distinct flow paths contributing to runoff after precipitation events is depicted in the data.

Integration of remotely sensed data with the WETSPA hydrological model for improved ET estimations in wetland ecosystem.

Joanna Suliga (1), Ann van Griensven (1) (2), Boud Verbeiren (1)

Vrije Universiteit Brussel
Presenter: Joanna Suliga
Type of Presentation: ORAL

Abstract
Wetlands offer important ecosystem services and due to their regulating functions they are important elements in river basin management. However, wetland hydrological processes are often poorly represented in hydrological catchment models. The rather static representation of land use/land cover in catchment models is not suited to present the dynamic behaviour of wetland processes and the wetland health status which is changing over time. Within the famework of the HiWET project (STEREO III Program – BELSPO), we aim to improve monitoring of wetlands health by integrating highly frequent remotely sensed (RS) data for Normalised Differential Vegetation Index (NDVI), Leaf Area Index (LAI) and evapotranspiration (ET). The RS data are combined with hydrological models to allow more up-to-date analysis for the Upper Biebrza catchment in Poland that includes wetlands ecosystem. Through application of different RS products and modelling, we are able to estimate evapotranspiration (ET) patterns in wetlands ecosystem which can be used for detecting changes and possible signs of degradation. For the integration of multi-source remote sensing data, bridging the trade-off between spatial and temporal resolution forms the major challenge. In this work we combine near-daily Proba-V satellite imagery (100m resolution), Landsat8 imagery (30m resolution and 16-days revisit time) with a snap-shot airborne APEX image (2m resolution). Proba-V satellite provides NDVI maps which are used for estimating spatial distribution of LAI in the catchment at the 100m resolution.

However, each 100m pixel might be a mixture of different land types, therefore highly resolution, hyperspectral APEX image is used to identify homogenous (dominated by one land type) pixels in derived from Proba-V LAI maps. Due to frequent revisit of Proba-V it is possible to obtain LAI maps for the whole season and therefore extraction of LAI values from pixels of known landuse provides dynamic curve of LAI for various vegetation types. Derived thanks to this method LAI dynamic curves are used for improving the estimation of ET from hydrological modelling. In addition to Proba-V, also space-born Landsat8 images are used to improve the performance of hydrological modelling and ET estimations. Scenes of Landsat8 can cover bigger area than air-born APEX therefore they are used for deriving landuse map for the whole catchment. Classes used for the landuse map consider vegetation types with different ET behaviour. Field data, collected during measurements campaigns in 2015 and 2016 in Biebrza Wetlands, together with processed RS data are used for evaluating the RS data. LAI measurements (done with Licor LAI canopy analyser) and spectral measurements (done with ASD field spec) collected during the field campaign were used for validation of RS various products. In addition, present on the side Eddy covariance tower can provide in-situ ET observations that can be particular interesting for comparison with modelling results. Continuous results of hydrological model WETSPA allow more up-to-date estimations of evapotranspiration and defining a typical ET temporal behaviour for various vegetation types. ET-based method of monitoring is using this knowledge to observe anomalies in evapotranspiration patterns and therefore identify possible areas of degradations.

S13 Cold region Ecohydrology, including alpine ecosystems and cold zones
Stefan Krause, Alexander Milner

Permafrost degradation impacts to stream ecosystems in polar regions
Michael Gooseff

University of Colorado
Presenter: Dr Michael Gooseff
Type of Presentation: ORAL

Abstract
Streams flowing through permafrost regions are susceptible to significant bank erosion due to bank-side permafrost degradation. This input of sediment is often spectacular and in discrete locations, though expected to impact long downstream segments of the stream network. In the Arctic North Slope of Alaska, we observe multi-year inputs of sediment to tundra streams from thermokarst features, though there was not as significant of alteration to the downstream ecosystem as expected. Metabolism and nutrient uptake were to similar to upstream, unaffected reaches. In the glacial meltwater streams of the Dry Valleys of Antarctica, lateral sediment inputs from permafrost degradation had significant biogeochemical impacts on streams, with increases of nitrate and some weathering solute concentrations, and a general fining of the stream bed. To date it has not been determined whether there are longer lasting impacts to these affected streams. Despite the spectacular view of these seemingly anomalous lateral inputs of sediment to polar streams, the ecosystems seem to be more resilient than expected.

The role and response of flows through fens in the Tanana Flats lowland of interior Alaska to permafrost thaw
M. Torre Jorgenson (1) Anna K. Liljedahl (2)

Cold Regions Research and Engineering Laboratory
Presenter: Dr Thomas Douglas
Type of Presentation: ORAL

Abstract
Increasing air temperatures are expected to have pronounced effects on hydrogeologic processes in permafrost terrains. The 5 degree C increase in mean annual air temperatures projected for interior Alaska by 2100 will initiate widespread permafrost deg¬radation. Permafrost and the surface cover of seasonally frozen soils have extremely low hydraulic conductivities so as summer progresses and seasonal thaw expands downward the storage of surface water and subsurface flows increase. As a consequence, water features underlain by permafrost exhibit an intense seasonality in their flow paths, discharge rates, and biogeochemistry. A warmer climate will lead to an earlier spring melt to summer transition, more rapid seasonal thaw, and, where permafrost degrades, an increase in lateral movement and storage of surface and shallow subsurface water. Of

particular note on a global scale is the 1,600 Pg of carbon currently stored in permafrost terrains, much of it in peatlands, which could be mobilized if permafrost thaws and/or terrestrial exports to rivers are altered by hydrologic regime changes in surface water features. Fens are geogenous peatlands influenced by surface or ground water flows that have been in contact with mineral soils. They have a minerotrophic vegetation typically consisting of mosses and sedges and are found in terrains with and without permafrost. Fens are often hydrologically linked to lakes and ponds and play a major role in nutrient cycling between aquatic and terrestrial ecosystems. We undertook this four year study of flows across fen systems in the 8,000 square kilometer Tanana Flats lowland of interior Alaska (Figure 1) to evaluate the role and response of fen systems to permafrost degradation. Objectives were to: 1) quantify seasonal hydrologic regimes in permafrost fen systems; 2) assess effects of winter snow accumulation and summer precipitation on water surface elevations and slopes; 3) quantify annual thermal regimes in fens as a contributor to permafrost degradation; and 4) determine short-term lateral permafrost degradation rates through analysis of high-resolution satellite imagery. We found fens typically occur in long narrow channel features that are likely remnant fluvially carved surface streams formed in the Pleistocene and Holocene when the area was underlain by continuous permafrost. The patchy forest along the fen channels reflects differences in stand age related to time since last fire, presence or absence of permafrost, and local flooding frequency. The fens exhibited a flashy response to snow melt runoff and early summer precipitation, likely due to limited storage available in seasonally frozen soils. However, in late summer and early fall lateral surface and shallow subsurface hydrologic flows were at their maximum and this expanded storage limited the hydrologic response of fen flows to precipitation. This represents how the fen flows will likely change when permafrost thaws. Our results suggest that over time, as permafrost thaws, surface water will move into the shallow subsurface to provide a source of heat to further exacerbate permafrost thaw (Figure 1). This could ultimately lead to drying of the fens and a marked change in the biogeochemical fluxes through and out of the fen systems.

Hotspots and hot moments; the control of structural heterogeneity on the thermal regime of the peatland soil-atmosphere interface

Rhoswen Leonard (1), Paul Moore (2), Nicholas Kettridge (1), Stefan Krause (1), Kevin Devito (3), and James Michael Waddington (2)

University of Birmingham
Presenter: Rhoswen Leonard
Type of Presentation: ORAL

Abstract
Peat surface temperature acts as a master variable driving non-linear terrestrial biogeochemical, ecohydrological, and micrometeorological processes, inducing short-lived extremes or spatially isolated events across heterogeneous peatland

surfaces. Changes to ecosystem structure such as canopy removal may change the temperature extremes and spatio-temporal location of these non-linear processes. In order to understand the impact of structural disturbances on peat surface thermal regimes, we simulate how different ecosystem structural layers (i.e. tree layer, lower vascular layer, bryophyte layer, micro topography) influence the spatial and temporal variability of peatland surface temperatures on a carbon rich forested peatland system. Simulations of peat temperatures are validated using more than 1.9 million peat surface temperature measurements across a 10 m2 area of peatland under un-disturbed, trees removed, and lower vascular vegetation removed conditions (through the use of Fibre Optic Distributed Temperature Sensing Technology). The simulations of peat temperature using different structural complexity allows us to determine how ecosystem layers may simplify or complicate surface thermal patterns and promote or dampen temperature extremes. Our study provides important insight into spatial and temporal variability in peatland biogeochemical functioning and the production of hot spots or hot moments in peatland carbon storage or export.

Insights into the effects of patchy ice layers on water balance heterogeneity in peatlands

Simon J Dixon (1); Nicholas Kettridge (1); Max Lukenbach (2); Paul Moore (3); Kevin J Devito (4); Rich M Petrone (5); Carl A Mendoza (2); Mike Waddington (3)

University of Birmingham
Presenter: Dr Simon Dixon
Type of Presentation: ORAL

Abstract
Northern peatlands represent an important sink in the global carbon cycle and are characterised by a high degree of seasonality. During winter soils are frozen and snow covers the surface preventing peat moss growth. Conversely, in summer, soils unfreeze and rain and evapotranspiration drive moss productivity with the landscape becoming more hydrologically connected. An important component of landscape hydrological connectivity in many northern peatland landscape mosaics can be shallow peatlands and marginal connective wetlands. Although advances have been made in understanding growing season water balance and moss dynamics in northern peatlands, research has typically focused on relatively deep bog systems during the growing season. There remain gaps in knowledge both of the ecohydrological function of shallow, marginal systems as well as inter-seasonal water balance as layers of ice break up during the spring thaw. The balance between moss productivity and water loss provide a key component of these systems, as water use efficiency controls the rate of moss growth and thus controls the amount of atmospheric carbon sequestered in peat under a changing climate. Understanding the effects of ice layers on spring water balance is important as this coincides with periods of high wildfire risk, such as the devastating Fort McMurrary wildfire of May, 2016. We hypothesise that shallow layers of ice disconnect the growing surface

of moss from a falling water table, and prevent water from being supplied from depth, leading to the drying out of the surface layer of moss and a greater risk of severe spring wildfires. We utilise the unsaturated flow model Hydrus to explore water balance in peat layers both with and without layers of simulated ice. Our results demonstrate a bimodal distribution of peatland responses; either primarily conserving water by limiting evapotranspiration or, maximizing productivity. For sustained periods of evaporative stress, shallow marginal systems are least able to buffer periods of evaporative stress due to limited labile water storage, and will limit evaporation, conserve water and be less productive. Where a solid ice layer is simulated water conserving areas limit evapotranspiration during dry periods and maintains moist conditions in the sub-surface. Conversely, peatlands which are more productive continue to grow moss and evaporate resulting in the water table dropping below the level of the ice and the near surface drying out. Where there are breaks in the ice layer the evaporating surface is able to maintain contact with a falling water table, but connectivity is limited to above the breaks, with limited lateral transfer of water above the ice. Conceptually this means that peatlands which tend towards higher levels of moss productivity are able to maintain moss growth during dry periods. In the presence of an ice layer this greater productivity leads to a disconnection from deep water sources, extensive drying out of moss above the ice, and a greater susceptibility to severe wildfires. Our study gives important insights into the mechanisms behind heterogeneity in burning and depth of burn in northern peatland wildfires, as well as into burn heterogeneity within peatland microtopography.

Revisiting the Flood Pulse Concept - How peatland hydrology influences spatial vegetation community distributions in a natural floodplain

Floris Keizer MSc, Dr. Paul Schot, Prof.dr. Martin Wassen (1) Ignacy Kardel (2)

Copernicus Institute of Sustainable Development, Utrecht University, NL
Presenter: Floris Keizer
Type of Presentation: ORAL

Abstract
We studied spatial patterns in inundation water quality, sediment and vegetation distribution in a floodplain fen in Poland to map interacting peatland hydrological processes. Using PCA and K-means cluster analysis, we identified four water types, related to river water inundation, discharge of clean and polluted groundwater, and precipitation and snowmelt dilution. Spatially, these hydrochemical water types are related to known water sources in the floodplain and occupy distinctive zones. River water is found along the river, clean and polluted groundwater at the valley margins and groundwater diluted with precipitation and snowmelt water in the central part of the floodplain. This implies that, despite the floodplain being completely inundated, nutrient input from river flooding occurs only in a relatively narrow zone next to the river. Our findings question the relevance of the edge of inundation, as

presented in the Flood Pulse Concept, as delineating the zone of input and turnover of nutrients. Secondly, we studied rich-fen and freshwater vegetation community distributions in relation to the presented inundation water quality types. We successfully determined inundation water quality preference for 14 out of 17 studied rich-fen and freshwater communities. Spatial patterns in preference show vegetation with attributed river water preference to occur close to the river channel, with increasing distance to the river followed by communities with no preference, diluted groundwater preference in the central part, and clean and polluted groundwater preference at the valley margins. In inundation water, nutrients are known to be transported mainly as attached to sediment, besides in dissolved state. This means that in the zone where sediment deposition occurs, nutrient input can be a relevant contribution to the nutrient input of the floodplain. We found a significant decrease in sediment-attached nutrient deposition with distance from the river. Sediment-attached nutrients correlated better to aboveground standing biomass than dissolved nutrients. These findings further reduce the spatial zone where significant nutrient input is influenced by transport from the river, compared to the zone influenced by dissolved nutrients. Our findings indicate the need for a revision of the Flood Pulse Concept for temperate river with multiple water sources, as peatland hydrological processes significantly influence spatial floodplain vegetation distribution.

Climate change and glacier shrinkage in Arctic and alpine streams; effects on physiochemical variables and biotic communities

Alexander M Milner1, P.J. Blaen1, Lee E Brown2, Catherine Docherty1 K.K. Khamis1, and D.M. Hannah1

University of Birmingham1, University of Leeds2

Presenter: Kieran Khamis

Type of Presentation: Oral

Abstract

In Arctic regions climatic change is modifying the relative contributions and temporal dynamics of water sources (rainfall, ice-melt, snowmelt, and groundwater) to river flow. These changes will have significant implications for physicochemical habitat and associated biotic communities. Evidence from a number of Arctic and also alpine studies indicates reductions in glacial meltwater runoff are expected to drive an overall increase in local alpha diversity and abundance, but a decrease in regional diversity and rareness as specialist cold water taxa become extinct. Aquatic systems downstream of glaciers may shift from one of a deterministic nature to one with greater stochasticity, both in terms of their physicochemical variables, associated biological communities and functional trait composition. Our understanding of potential ecological tipping points and associated indicator taxa is limited but data from a number of regions have identified threshold changes in community composition of stream taxa at <5.1% glacier cover and <66.6% meltwater contribution. An unexpected impact of glacier volume loss has been the

liberation of contaminants, including pesticides and other persistent organic pollutants, from the early industrial revolution and onwards. A recent concern has been regarding uncertainty is how climate change is shifting these contaminants from glacial stores to other ecosystems, with potential detrimental effects. We present new conceptual models of the major shifts envisaged this century for these important features of aquatic systems downstream from glaciers. Management strategies are outlined to mitigate the societal impact of these changes in glacial runoff, with key priority research areas identified to inform these strategies.

S14 Ecohydrology of urban landscapes under change
Anne Jefferson

Urban Stormwater Infrastructure at City, Regional, and National Scales

Rebecca Hale

Idaho State University
Presenter: Rebecca Hale
Type of Presentation: ORAL

Abstract
Urbanization is associated with dramatic changes to land cover and stream networks – including stream burial, stream rerouting, changes to drainage density, and the creation of novel hydrologic features – largely as part of stormwater management. While the hydrologic impacts of land cover change are well understood, less is known about how the diversity of stormwater management practices affect hydrologic patterns, nor how stormwater management practices are distributed over space and time. This presentation will focus on heterogeneity in stormwater infrastructure design across spatial scales and over time. We ask: How does stormwater infrastructure vary within cities, within regions, and across the US? How does infrastructure use vary over time? And how does infrastructure use vary across built, social, and environmental gradients? Within cities, infrastructure use varies significantly over time, with shifts from conveyance infrastructure (storm sewers) to more retentive structures. These patterns are due to shifts in stormwater management paradigms and have significant implications for material transport from urban watersheds. Within regions, patterns of infrastructure use are variable over space and time, largely due to the timing of urban development. Across the United States, the density of storm sewers is strongly correlated to potential runoff, while the use of green infrastructure is less related to biophysical and build context. A fuller understanding of stormwater infrastructure heterogeneity and its effects is essential to modeling the impacts of urbanization and climate change on hydrologic processes currently and into the future.

Impacts of stormwater runoff on the soil and water quality of an urban prairie nature preserve

Liliana M. Hernandez, Vivien A. Rivera, Haebin Chang, Loren E. Yeager, Shelby Hatch, Loren Ayala, Diella Packman, Julia Standley Pradhan, Nanxi Lu, Karl J. Gnaedinger, M. Cristina Negri, William M. Miller and Aaron I. Packman

Northwestern University
Presenter: Liliana Hernandez
Type of Presentation: ORAL

Abstract
One of the expected effects of climate change within the next few decades is an increase in the intensity and frequency of rainfall events. This will aggravate stormwater runoff and adversely affect water quality in urban environments. Heavy metals in urban runoff can be transported to and deposited within green spaces, shallow groundwater, and regional aquifers – thereby degrading the quality of water and soil resources. We assessed the impacts of stormwater runoff and contaminants derived from roads and urban development on the water and soil quality of an urban prairie nature preserve: Gensburg Markham Prairie (GMP), a unique undisturbed (never plowed or developed) tallgrass prairie located in Markham IL, within the greater Chicago megacity. GMP is managed by Northeastern Illinois University (NEIU) and The Nature Conservancy (TNC) and it has been named a National Natural Landmark due to its important biodiversity, including rare endemic species. While GMP itself is undisturbed, it is surrounded by high-traffic highways and residential communities. Stormwater runoff and heavy metals inputs into GMP are a concern for NEIU and TNC because of observed ecosystem degradation around its periphery and potential long-term impacts on the prairie. To understand the biogeochemical status of the prairie and potential degradation due to inputs from surrounding urban developments, we collected 1-m soil cores during summer 2016 from 14 locations in GMP, and analyzed spatial patterns in soil size, texture, and biogeochemistry. Water samples were also collected monthly on an ongoing basis from 8 surface-water sampling sites (pond, channels) and 11 groundwater wells. These samples were analyzed using Inductively Coupled Plasma Atomic Emission Spectroscopy (ICP-AES) to determine concentrations of copper (Cu), lead (Pb), magnesium (Mg), iron (Fe), potassium (K), calcium (Ca), and phosphorus (P). Visual-manual classification identified clayey silt soils in a water pond in the northern part of GMP and sandy silt soils in a ridge bisecting the prairie. Concentrations of Pb and Zn in the soil profile were primarily located in the surficial soil (0-10 cm depth) implying atmospheric deposition. Pb was elevated in soil at the highest point in the prairie located in the sand ridge. High concentrations of Mg, Fe and K were observed at deeper soil horizons (80-120 cm) in the soil samples collected from the water pond. Concentrations of Fe in the soil profile of the water pond range from 2000 to 6000 mg/kg. Higher concentrations of Cu were present at the depth of the water table (80-90 cm). Results from water samples showed low concentrations for the metals of interest, indicating a minimal impact to the water resources at GMP, as is expected for a nature preserve. Future work includes the assessment of road salt intrusion to the site by measuring sodium (Na) and chlorine (Cl), particularly on the eastern boundary adjacent to major highways. The detailed soil and water chemistry data constitute a dynamic spatial contamination map that can be used to assess long-term impacts on the ecosystem and also to inform NEIU and TNC for their site management and biodiversity conservation efforts.

Integrated hydrological assessment of an urban nature preserve using a high-frequency sensor network

Vivien Rivera, Liliana M. Hernandez, Loren Ayala, Colin Phillips, Adwaith Nair,

Karl J. Gnaedinger, Pete Beckman, Rajesh Sankaran, M. Cristina Negri, William M. Miller,
Aaron I. Packman

Northwestern University
Presenter: Vivien Rivera
Type of Presentation: ORAL

Abstract
Urban greenspaces, including green roofs, parks, and community gardens, provide myriad ecosystem services. Design and management tools for effective, healthy urban greenspaces include models of water and nutrient dynamics in response to climate and human activity. Such models, combined with robust data sets, allow for evaluation of potential problems which can impact the effectiveness of urban greenspaces. We are developing and applying these tools at the Gensburg Markham Prairie (GMP), located in Markham, Illinois south of Chicago and owned by Northeastern Illinois University. GMP, is a major urban nature preserve, a U.S. National Natural Landmark, and one of the few remaining undisturbed tallgrass prairies in the Midwest. In addition to providing ecosystem services including biodiversity and stormwater storage, GMP provides both a reference ecosystem for restoration of Midwestern prairies and a sentinel ecosystem for changing regional climate. We installed a suite of instruments to measure surface and groundwater levels, soil moisture, and electrical conductivity throughout the prairie, as well as a network of atmospheric monitoring stations called Waggle nodes, developed by Argonne National Lab. The Urban Sensing infrastructure in Chicago called the "Array of Things" also uses the Waggle technology platform. Waggle nodes measure more than 20 variables, including temperature, relative humidity, barometric pressure, sound level, reactive gases including carbon monoxide and ozone, and 5 wavelengths of light from infrared to ultraviolet, and include cameras for cloud cover, runoff extent and flooding, and other image-based data collection. These nodes stream data in near-real-time to a publicly-accessible data portal. In 2016 and 2017, we installed 13 piezometers with pressure transducers to measure groundwater head, 8 pressure transducers to measure surface water levels in drainage channels around the prairie, 2 soil moisture profile probes with integrated electrical conductivity sensors, 6 soil electrical conductivity probes, 2 water electrical conductivity probes, a tipping-bucket rain gauge, and 4 Waggle nodes. The Waggle nodes collect and upload data every 30 seconds, and all other sensors collect data every 30 minutes. The high measurement frequency and large diversity of sensor types supports holistic investigation of the response of the prairie to diverse hydrologic events, including summer thunderstorms and spring snowmelt. These high-quality data streams facilitate the development of a model for water runoff and storage dynamics at the GMP site using MODFLOW and time-series modeling frameworks. These models are useful as management tools for site operators, teaching tools for students and community members who live and work near natural greenspaces, or design tools for engineers and scientists intending to construct and maintain new kinds of healthy urban greenspaces. We collaborate

with nonprofit organizations and The Nature Conservancy to connect with communities around Chicago to share the results of our work and provide access to the tools that we are developing.

Effects of green infrastructure on stream base flow and groundwater recharge

Aditi Bhaskar

Colorado State University
Presenter: Dr Aditi Bhaskar
Type of Presentation: ORAL

Abstract
Distributed, infiltration-focused approaches to stormwater management are being implemented to mitigate the effects of urban development on water resources. One of the goals of this type of stormwater management, sometimes called green infrastructure, is to maintain groundwater recharge and stream base flow at pre-development conditions. However, the connection between infiltration-focused green infrastructure, groundwater recharge, and stream base flow is not straightforward. Water infiltrated through stormwater facilities may be stored in soil moisture, taken up by evapotranspiration, or contribute to recharge and could later discharge as local stream base flow. Here, continuous water table fluctuations are used to quantify the movement of infiltrated stormwater, and base flow records during and after urbanization are used to quantify trends in base flow. This study focuses on a 1.1 km2 suburban, green infrastructure watershed in Clarksburg, Maryland, USA, which was urbanized with 73 infiltration-focused stormwater facilities. The episodic master recession method of analyzing water table fluctuations was used, time series analysis was performed on the hydrographs of seven wells, and trend analysis was performed on the stream base flow records of the study stream and two reference streams. Stream base and total flow both were found to increase during development, relative to flow in reference urban and forested watersheds. Persistence in water levels, as represented by the autocorrelation function, was related to depth to water. The recharge to precipitation ratio was inversely related to precipitation magnitude and rate, and positively related to precipitation duration, pre-event storage, and the distance between the well and the stream. This work may be used to evaluate the effects of watershed-scale infiltration-focused stormwater management on groundwater flow systems and stream base flow.

S15 Dryland and drought ecohydrology

Anne Van Loon, Tom Pugh

Plants under drought stress: shifts of hydraulic plant strategies and ecohydrological processes in response to climate

Britta Tietjen Gregor Ratzmann

Freie Universität Berlin, Institute of Biology
Presenter: Britta Tietjen
Type of Presentation: ORAL

Abstract
Dryland plants have developed different strategies to cope with water stress. By regulating their water uptake and transpiration losses they can endure harsh and highly variable climatic conditions. Water uptake of plants is regulated by the hydraulic strategy: while isohydric plants maintain relatively constant leaf water potential and therefore stop carbon assimilation under unfavorable conditions, the leaf water potential of anisohydric species can nearly match that of soil water potential with the risk of xylem cavitation under drought conditions. Water losses by transpiration depend on the photosynthetic pathway, with C3 and C4 plants performing differently on gradients of aridity and temperature. Here, we present an ecohydrological simulation study on the performance of different plant strategies under various climatic conditions in drylands. We use an extended version of the model EcoHyD (Tietjen et al. 2009, 2010, Guo et al. 2016), which simulates water dynamics in two soil layers and the resulting vegetation dynamics of different plant functional types (PFTs) at the landscape scale. The simulated PFTs differ in their growth form, their hydraulic strategy and their photosynthetic pathway. We systematically evaluate the impact of rainfall, temperature and atmospheric CO2 on the resulting composition of plant functional types in hot drylands, and determine which strategy performs best for a given environmental setting. In addition, we assess the impact of plant strategies on ecohydrological processes such as carbon gain in response to water availability or transpiration. With this study, we show potential shifts in plant function types under future climatic conditions and resulting changes of ecosystem functioning.

Water and vapor transfer in vadose zone of Gobi desert and riparian zone in the hyper arid environment, experiment and simulation

Jingjie Yu Ping Wang

Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences
Presenter: Chaoyang Du
Type of Presentation: ORAL

Abstract

To reveal how Vapour and heat transfer in vadose zone affect evapotranspiration in Gobi desert and riparian in hyper arid region is important for understanding eco-hydrological process. Field studies and numerical simulations were imported to evaluate the vapour and heat movement processes under non isothermal and lower water content conditions. The soil profiles in Gobi desert site of Ejina were installed with sensors to monitor soil moisture and temperature for 1 year. The meteorological conditions and water table were measured by micro weather stations and mini-Divers respectively in the two sites. Soil properties, including particles composition, moisture, bulk density, water retention curve, and saturated hydraulic conductivity of two site soil profiles, was measured. The observations showed that soil temperatures for the two sites displayed large diurnal and seasonal fluctuations. Temperature gradients with depth resulted in a downward in summer and upward in winter and became driving force for thermal vapour movement. Soil moistures in Gobi desert site were very low and varied slowly with time. While the soil moistures in riparian site were complicated due to root distribution but water potentials remained uniform with time. Transient one dimensional flux of soil water and heat in response to 1 year atmospheric forcing were simulated numerically for the Gobi desert site.

Ecological Rehydration Index - An empirical tool to determine the water source and status of dryland riparian trees developed in the Pilbara region of Western Australia

Duncan Storey Daniel Huxtable

AQ2 Pty Ltd
Presenter: Mr Duncan Storey
Type of Presentation: ORAL

Abstract
In the semi-arid Pilbara region of Western Australia, riparian forests and woodlands dominated by Eucalyptus victrix, E. camaldulensis and less commonly Melaleuca argentea have important cultural and conservation values. Hydrological change caused by iron ore mining, including groundwater abstraction (around 100 MCM per year) and surplus water disposal to surface drainages, has the potential to negatively affect these riparian vegetation communities. To manage the risk of hydrological change, it is necessary to determine the relative importance of vadose-zone water or groundwater to the riparian trees. We have developed an Ecohydrological Rehydration Index (ERI) using predawn and midday leaf-water potential (?leaf) data. Predawn ?leaf provides a proxy for matric pressure in the root-zone, whilst midday ?leaf indicates the maximum hydraulic gradient developed at the canopy transpiration flux surface. The ERI is diagnostic of trees that do not use groundwater, defines thresholds for tree-water status and allows correlation between tree-water status and driving-factors such as groundwater level decline and climatic variables. Time-series data were analysed, comprising some 3,000 measurements of pre-dawn and midday ?leaf from mining-company and government monitoring. The time-series covered all key riparian species for the

period 2009 to 2016, during which mining impacts increased and the climate sequence comprised wet and dry years. Two species specific thresholds are proposed: a higher predawn ?leaf below which groundwater use is excluded; and a lower predawn ?leaf below which the tree is at risk of hydraulic failure. The difference between predawn and midday ?leaf collected on the same day represents the hydraulic driving force required for the tree to take up soil water (i.e. ??). This ?? differential, in combination with absolute values of predawn ?leaf, provides insights into tree-water sources and the ability of trees to rehydrate on a diurnal basis. Normalisation of this ratio provides a single indicator of tree-water status (the ERI). Four ERI zones are defined: • Zone 1: Potential Groundwater Use; characterised by high levels of rehydration (ERI >˜0.7) and predawn ?leaf values above the species-specific upper thresholds. • Zone 2: Vadose-water use – high water availability; characterised by high levels of rehydration (ERI >˜0.7) and predawn ?leaf values below the species specific upper thresholds. • Zone 3: Vadose-water use – constrained water availability; characterised by moderate levels of rehydration (ERI between about 0.3 and 0.7). • Zone 4: Vadose-water use – limited water availability (drought stress); characterised by low levels of rehydration (<˜0.3) and predawn ?leaf values below the species specific lower thresholds. Where trees use groundwater the ERI correlates with metrics of groundwater availability (e.g. depth to water table); whereas for trees using vadose-zone water the ERI correlates with controls on vadose-zone water availability such as time since rainfall or surface flow. The approach can assist in determining key water-sources for riparian trees and the efficient monitoring of riparian systems most at risk from hydrological disturbance. The ERI could possibly be applied in other dryland areas where riparian vegetation is at risk from hydrological change.

Loss of habitat and connectivity during drought

C Laize N Nineham M Dunbar D Hannah V Bell M Acreman

Centre for Ecology and Hydrology
Presenter: Cédric Laizé
Type of Presentation: ORAL

Abstract
This study focuses on eco-hydraulics as a mean to assess the impact of drought on river ecosystems. The health of a river is influenced by many interacting natural and anthropogenic factors among which is flow (discharge). While all facets of the flow regime are important to river ecosystems, discharge has only an indirect effect. Indeed river organisms respond directly to river hydraulics in terms of: (i) available physical habitat (ie depth, velocity) created by the interaction between flow and channel morphology; (ii) river longitudinal connectivity (ie less opportunity to explore food sources, or to find most suitable conditions when connectivity is broken). During a drought, the decrease in discharge first cause a loss of physical habitat, then of connectivity. We chose to represent river hydraulics using Hydraulic Geometry (HG), which is a simple characterisation of river hydraulics as wetted

width, mean water depth, and mean water velocity modelled as power functions of flow in natural rivers. We fitted HG models at about 3000 sites in England and Wales. Firstly, we aimed to understand better river hydraulic sensitivity to flow variability and, to assess how catchment properties can influence this. HG models coefficients were analysed against a wide range of catchment descriptors. Secondly, for a subset of sites covering a wide geographical area, we generated time series of depth, width, and velocity. We quantified typical habitat loss at sites during drought years. Site information was then aggregated at catchment level to assess how fragmented they are under drought conditions. Results were mapped. The approach was used with both historical and projected future discharge data.

Temporary streams in temperate zones: recognizing and monitoring the ecological quality of transitional aquatic-terrestrial ecosystems

Rachel Stubbington, Judy England and Paul J. Wood

Nottingham Trent University
Presenter: Rachel Stubbington
Type of Presentation: ORAL

Abstract
Temporary streams, which sometimes stop flowing and may lose all surface water, are the dominant lotic ecosystem type in drylands and are also common in temperate regions, including those in which an oceanic influence creates a cooler, wetter climate. The dynamic ecohydrology of these transitional aquatic-terrestrial ecosystems is receiving unprecedented research attention, in particular in drylands, but also in other temperate regions. Focusing on oceanic regions, we highlight that temporary streams contribute to wider ecosystem functioning, with many supporting high biodiversity. We propose two conceptual models: to illustrate that temporary stream biodiversity can be higher than in perennial systems, particularly when beta- and gamma-diversity are considered; and to relate this diversity to transitions between lotic, lentic, and terrestrial conditions. Ubiquitous human impacts on temporary streams reflect water-resource and land-use related stressors, which interact with climatic drivers to alter flow permanence regimes. Such hydrological impacts, as well as anthropogenic changes to physical habitats and water quality, may prevent attainment of the ecological quality required by international legislation. Research is therefore needed to overcome barriers to the integration of temporary streams into biomonitoring programmes in oceanic regions, informed by recent advances in mediterranean drylands. Priorities include classification of temporary streams into ecologically relevant categories; characterization of biota representing reference and degraded conditions in each category; development of novel biomonitors to assess ecological quality during dry phases; and determination of new multi-metric indices that integrate biomonitoring data from lotic, lentic, and dry phases.

Posters

Adapting the operation of cascaded reservoirs on Yuan River for fish habitat conservation

Xin Wen, Guo-hua Fang, Yu-xue Guo, Lei Zhou

Hohai University
Presenter: Dr Xin Wen
Type of Presentation: POSTER

Abstract
To alleviate the negative impacts on ecosystem caused by cascaded development of Yuan River, this study quantified the ecological requirements and incorporated them into the cascaded reservoir operating schemes to provide the streamflow that balances fish habitat protection and hydropower generation. Physical habitat simulation model is proposed to simulate the relationship between streamflow and physical habitat for various life stages of Cyprinus rubrofuscus Lacépède and Bagarius rutilus Ng & Kottelat, and to determine the ecological requirement as a discharge range associated with the upper area of a certain proportion of maximum Weighted Usable Areas (WUA). Then the optimal operation model of cascaded reservoirs is established. Maintaining over 70 percent of maximum WUA as an example, the optimization technique could increase the hydropower generation of cascaded reservoirs by 3.60%, 1.93% and 4.19%, and also improve the ecological conditions by increasing the WUAs by 11.3%, 17.9% and 16.2% for Section A and 7.4%, 12.4% and 14.4% for Section B under wet, normal and dry conditions, respectively. Furthermore, the trade-offs between hydropower production and fish habitat conservation are discussed. The optimal compromises were identified at the knick points in the established relations where 50%–70% of maximum WUA are conserved at a cost of 11.72-52.11 billion kW·h (1.8%–8.4%) power generation loss.

Investigating how plant functional traits can increase the efficiency and capacity of vegetated buffer zones.

Aimee Brett Prof. John Quinton Dr. Carly Stevens Dr. Martin Blackwell

Lancaster University
Presenter: Aimee Brett
Type of Presentation: POSTER

Abstract
Investigating how plant functional traits can increase the efficiency and capacity of vegetated buffer zones. Using vegetated buffer zones to reduce pollution from agricultural fields into water courses has been a much studied area. However, during extreme weather events buffer zones fail and pollution from sediment, phosphorous and nitrogen into water courses still occurs. Buffer zones are easy to

implement and are generally accepted by farmers so enhancing buffer zones and ensuring they have increased efficiency and capacity could be an effective way to reduce diffuse pollution from agriculture. This project aims to identify a suite of plant functional traits that allow vegetated buffer zones to reduce the amount of sediment, phosphorous and nitrogen that travels through the buffer zones and decrease their failure rates after extreme weather events. Initially five common agricultural/grassland plants will be investigated for their ability to protect soil from surface erosion, slow the flow of water, return to standing after a heavy flow event, capture sediment, promote water infiltration, cycle nutrients quickly and leave standing biomass during the non-growing season. The plants will have leaf, stem, root and whole life traits tested to determine their potential for carrying out the ecosystem services required at different life-cycle stages including first established, mature and degenerate. The plants will be subject to testing using a flume experiment to determine their ability as mono-cultures, mixtures and at different life stages to carry out the above mentioned services using dye and sediments flow experiments, hydraulic conductivity experiments and general pot experiments. This poster will present the initial findings from the plant functional trait testing and the detailed designs and early results from the flume experiments. These results will be used to inform the design of field experiments planned to be monitored over several years. The results will also be used to investigate the way individual plant traits and mixtures of traits affect the ability of the plant to reduce the diffuse pollution and ensure the vegetated buffer zone continues to provide pollution reduction services.

Spatio-temporal dynamics of evapotranspiration from forested, ephemeral wetlands and its implication for hydrologic connectivity in the Boreal Plain, Canada

Alexander Hurley, Nicholas Kettridge, Kevin Devito, Kelly Hokanson, Rhoswen Leonard, Stefan Krause, James Michael Waddington

University of Birmingham
Presenter: Mr Alexander Hurley
Type of Presentation: POSTER

Abstract
In catchments where hydrologic connectivity is predominantly controlled by storage-threshold dynamics, landscape units promoting water transmission can be crucial for overall ecohydrological functioning. In Canada's Western Boreal Plain, ephemeral wetlands surrounded by upland forests on deep and coarse, glacial deposits are examples of such units. In the sub-humid climate, their importance is exacerbated due to regional, multi-year water deficits, resulting from high evapotranspirative (ET) demand coinciding with most of the annual precipitation and its variability between years. Yet, these ephemeral wetlands frequently saturate during small rain events; hence, they likely play a key role in supplying water to adjacent and downstream systems in both dry and wet periods. We assess factors

controlling water losses from these wetlands to the atmosphere (via the soil surface and vegetation), how they change over time (i.e. throughout the growing season), and the extent to which they vary in space. Our goal is to generate process-based understanding of ET dynamics and to determine potential feedbacks that reduce ET losses, maximizing the magnitude and period over which these landscape units may act as water sources. We hypothesize that the following mechanisms enhance the ascribed water transmitting function: (1) external and internal shading reduces incident radiation and therefore available energy to drive ET; this effect increases with leaf area, but is counter-acted by interception. (2) Vegetation structure reduces turbulent exchange with air masses above the canopy, thereby decreasing humidity gradients driving ET. (3) High, near-surface soil tensions during periods of drying limit rates of evaporation. We applied a combined measurement approach to assess spatial and temporal dynamics of ET in the 2016 growing season (May - August) and gathered additional data to assess abiotic and biotic controls on ET rates. We continuously measured ET from the wetland's surface via automated, closed-dynamic chambers (CDC) and whole-tree transpiration (sap flow) of individuals within and adjacent to the wetland, and determined spatial variability with a manual CDC system across the wetland mid-season. Ultimately, this work will generate process-based understanding of ephemeral wetlands as water transmitting features. It will thereby contribute to the growing knowledge base on storage-threshold and connectivity dynamics in Western Boreal Plain catchments.

Examining the relationships between large wood and hyporheic invertebrates across lowland reaches

Chiara Magliozzi, Robert Grabowski, Martin Janes

Cranfield University
Presenter: Mrs Chiara Magliozzi
Type of Presentation: POSTER

Abstract

Large wood is a key element for the hydrology, morphology and ecology of river channels, and has become a design element of many restoration schemes. Indeed, previous studies have shown that the introduction of wood into a stream induces changes in: i) flow turbulence and diversion ii) channel structural complexity (i.e. pool frequency, depth and sinuosity of the river profile) iii) carbon input and habitat availability. The connection between wood structure and its ecosystem functions (e.g. habitat and food resource), has been extensively described for benthic macroinvertebrates in both lowland and upland rivers but not on hyporheic invertebrates. Large wood has been hypothesized to have a major role in enhancing hyporheic exchange flows, which is an essential prerequisite for the presence of a hyporheic ecological community but study has directly investigated this link. Therefore, this study examined the effects of in-channel wood on the physical habitat and hyporheic communities of a lowland river. Hyporheic invertebrates were investigated seasonally within the benthic and hyporheic zone of two reaches in the Hammer catchment, in UK. The two reaches have distinct characteristics and

differ by sediment type (i.e. fine sand and gravel), geomorphology and hyporheic exchange. Invertebrate samples were collected along with measures of streamflow, sediment size, water chemistry and wood morphology. Biotic and abiotic parameters were analyzed with multivariate analysis and in terms of taxonomic diversity and functional composition. Preliminary results of this study show that large wood is a source of consistent patterns of habitat variability within the reaches. Such effects were more visible in the sandy reach where wood represents the main source of in-channel structural complexity. The outcome of this study benefits river restoration by providing measurable ecological outcomes and by understanding the role of wood in mitigating physical, hydrological or chemical alterations that are responsible of hyporheic taxa survival. Finally, this study highlights that the diversity of structural and abiotic conditions is related to the hydrological connectivity of the catchment and therefore provides new insights into the response of ecological communities to hyporheic drivers.

Zooplankton influence on phytoplankton biomass and community structure in rivers

Prof. Andrew Wade, University of Reading Dr. Mike Hutchins, Centre for Ecology and Hydrology Dr. Mike Bowes, Centre for Ecology and Hydrology

University of Reading/Centre for Ecology and Hydrology, Wallingford
Presenter: Mrs Anna Freeman
Type of Presentation: POSTER

Abstract
Harmful algal blooms in rivers can be prevented when all processes of their development and termination are fully understood. It has been established, that factors such as residence time, water temperature, nutrient chemistry and light alone do not completely explain phytoplankton fluctuation in rivers. This study is focused on biological control of algal dynamics, mainly on zooplankton 'grazing' effects. It was conducted on the River Thames, UK. Zooplankton were surveyed weekly, between March-October 2015. Organisms were counted and identified to genus and possibly species levels from nine sites along the catchment, including three tributaries. The zooplankton were dominated by rotifers, with a maximum of approximately 9000ind./m3 recorded in summer in the lower-Thames. Every rapid increase in rotifer numbers occurred following centric diatom blooms, typically with a 1-2 week delay. Micro-crustaceans were generally found in larval stages and did not develop significant densities (maximum of 125ind./m3 in spring in the middle-Thames) (Fig.1). The significance of grazing impact on algal dynamics was experimentally tested at multiple sites across the Thames. A series of mesocosm experiments were undertaken in the growing season of 2016. In all experiments, phytoplankton and zooplankton diversity and densities were maintained close to their natural conditions. Temperature, light and nutrient concentrations were monitored. Experimental data revealed a moderate to non-significant grazing effect throughout the spring-summer period, with indications of small numbers of zooplankton actually promoting algal growth. Microscopic examination of fresh

samples highlighted a rise in algal mortalities due to algicidal bacteria and fungal parasites. Further work is being planned to explore this potential cause of high algal mortalities.

Suspended sediment transport and streambed clogging under losing and gaining flow conditions

Aryeh Fox, Aaron Packman, Antonio Preziosi-Ribero, Angang Li, Shai Arnon

1. Zuckerberg Institute for Water Research, The J. Blaustein Institutes for Desert Research, Ben-Gurion University of the Negev, Israel 2. Northwestern Center for Water Research, Northwestern University, U.S.A.
Presenter: Aryeh Fox
Type of Presentation: Poster

Abstract
Transport and deposition of suspended sediments in streams can affect the streambed hydraulic characteristics due to clogging, reduce water fluxes through the hyporheic zone, and thus negatively affect hyporheic communities and biogeochemical processes. The underlying processes affecting deposition of suspended particles over dune-shaped bed forms were previously studied in laboratory flumes. These experiments did not take into account the interactions with groundwater, which was shown to play an important role in deposition patterns of fine sediments in field studies. The objective of this study was to systematically evaluate the effect of losing and gaining fluxes on suspended sediment depositional patterns in sandy streambed and on hyporheic exchange fluxes. Experiments were conducted in a recirculating laboratory flume system (640 cm long and 30 cm wide) that has a capacity to enforce losing or gaining flow conditions. The flume was packed with homogenous sand, while suspended sediment deposition was evaluated by adding kaolinite particles to the water and following its rate of deposition by particle disappearance from the bulk water. Consecutive additions of kaolinite were done, while hyporheic exchange fluxes were evaluated between the kaolinite additions by conducting NaCl tracer experiment. Furthermore, dye additions were used to follow flow patterns in the streambed by visualizing the flow path using time-lapse photography through the transparent sidewalls of the flume. We will use hyporheic exchange filtration modeling and particle tracking simulations to assess the results of particle deposition feedbacks between hyporheic flow, particle transport, and streambed clogging. Experimental results showed that increasing losing and gaining fluxes resulted in a similar decline in the hyporheic exchange flux. Dye additions revealed that the depositional sites along the bed form are different under losing versus gaining flow conditions (Figure 1). Experiments and analysis showing the depositional patterns of suspended particles are ongoing and will be discussed in the poster presentation. The underlying mechanisms of particle deposition under losing and gaining flow condition are expected to improve our understanding of the dynamics streambed characteristics, which has implications to sediment transport, hyporheic exchange, biogeochemical processes and hyporehic ecology.

Catchment-scaled species diversity modeling of stream invertebrates using a hydrological simulation

Kei Nukazawa, So Kazama, Kozo Watanabe

University of Miyazaki
Presenter: Dr Kei Nukazawa
Type of Presentation: POSTER

Abstract

The development of a predictive framework for the geographical distribution of species diversity is an important task for freshwater ecosystems, which are globally affected by various anthropogenic alterations. Therefore, we developed species distribution models of macroinvertebrates to predict the geographical patterns of species diversity using a distributed hydrological–thermal (hydrothermal) model and examined it with different statistics. The study was initiated by running the hydrothermal model to calculate current velocity, water depth, and water temperature throughout the Natori River catchment located in northeast Japan during 2006. We subsequently compiled datasets comprising individual numbers of 41 taxa of stream macroinvertebrates observed in 2006 as response variables, and annual metrics of hydrothermal simulation outputs (e.g., annual mean current velocity) and geographical data as predictor variables of habitat modeling. We utilized three modeling techniques: histogram analysis, kernel density estimation, and general linear modeling. Models were evaluated using the area under curve (AUC) in the receiver operating characteristic (ROC) to determine the best model of the three techniques for each taxon. For estimating taxon richness, we defined species' presence or absence using the sensitivity plus specificity maximizing approach (Youden's index) in the ROC plots which has been designated as one of the most robust approaches for determining the threshold values of occurrence. Overall, the accuracy of the linear models was lower than that of the other two methods, as observed by significant differences in the AUC. However, several taxa (n=19), particular those in Plecoptera that were associated with water temperature, displayed an almost equivalent level of accuracy (i.e., AUC) among the three methods ($P = 0.44 \sim 046$, t-test). These findings indicate that water temperature may be a good predictor for the geographical distribution of some stream invertebrates. Our results indicate that model accuracy (i.e., AUC) is negatively correlated with species prevalence as the ratio of the presence sites for each taxon. This is the first finding that the smaller prevalence of species may increase the predictability of habitat models for stream invertebrates, as well as other biomes. Finally, habitat models with the highest AUC out of the three methods ($n = 41$) were stacked to predict taxon richness, and significant positive correlations ($P < 0.05$) were observed. Utilizing our model, extrapolating the species diversity in the context of anthropogenic alterations such as climate change is a promising approach.

The Research of Ecological Environmental Water Demand in the Typical Area of the Yellow River Basin, China

Chuanzhe Li Ximeng Wang Jia Liu Yang Wang Qingtai Qiu

China Institute of Water Resources and Hydropower Research
Presenter: Dr Chuanzhe Li
Type of Presentation: POSTER

Abstract
To strengthen ecosystem environmental protection of Yan River Basin, ensure the water using in the area where the ecological environment is frail, and provide the theoretical basis for the management of ecological environment, the ecological environmental water demand which consist of river part and land part in the Yan River Basin was probed into using hydrology method, water quantity balance method and area norm method etc. based on the geographic information system technology (GIS) and remote sensing technology (RS). According to the result: (1) The hydrological variables distribution of the Yan River Basin in a year is very uneven, precipitation, runoff and sediment transport concentrated in summer; (2) The ecological environmental water demand of river can be met on conditions that the sediment transport water demand was met because of the mutli-use of water in the river. Ecological water demand of vegetation account for about 99.9% of the ecological environmental water demand of land while the ecological water demand of town account for only 0.1% of the ecological environmental water demand of land in the Yan River Basin; (3) Available water supply of maximum annual runoff account for only 23.8% of the ecological environmental water demand, which means water resources crisis is emerging and the ecological environmental water demand can't be met in the Yan River Basin.

A conceptual model of riparian forest development and channel processes interactions

Simon J Dixon (1); David A Sear (2); Tim Sykes (3); Keith Nislow (4)

University of Birmingham
Presenter: Dr Simon Dixon
Type of Presentation: POSTER

Abstract
The riparian ecotone is the interface between the aquatic and terrestrial environments and has substantial influence on conditions within both, particularly in the case of riparian forests. Riparian forests influence hydrology, channel form and channel processes, and this influence can be both direct and indirect through input of dead wood. Forested floodplains are recognised as providing a range of positive effects to the aquatic and terrestrial environments; providing coarse particulate organic matter to the channel, providing shade, increasing bank stability, creating geomorphic diversity on the floodplain and in the channel and created niche habitats for a variety of birds, animals and plants. As knowledge of the range

of ecosystem services provided by riparian forests has increased, policy and practice in the US and Europe has turned towards protecting forests and encouraging forest restoration. Recently this has seen increasing interest in the context of Natural Flood Management. In order to predict and understand the effects of restoring riparian forests it is necessary to understand the development of new stands of trees over time. However, comprehensive studies of riparian forest dynamics are few. Knowledge from upland forest plots cannot be applied uncritically due to the complicating influence of allogenic disturbance from the fluvial environment, leading to a harsh non-equilibrium environment. Seeds are transported and dispersed in the current, and can be preferentially deposited on bars. Bank erosion can fell trees, and ground water levels promote or inhibit colonisation by different species. In this paper we present the result of a heuristic modelling investigation into riparian forest restoration using a riparian forest growth model (NE-CWD) developed by the US Department of Agriculture Forest Service. We conduct models of a range of forest restoration scenarios with different species composition and obtain predictions of stand density, live and deadwood biomass and quantity of dead wood in the river channel over time. Using these results we develop a conceptual model of riparian forest growth, and show that a riparian forest moves through three broad phases of development with forest biomass and in-channel dead wood biomass showing a non-linear relationship.

The effect of colour on microplastic ingestion in Daphnia magna

Katie Reilly, Iseult Lynch and Jon Sadler

University of Birmingham
Presenter: Katie Reilly
Type of Presentation: POSTER

Abstract

The evidence of microplastic contamination has been established globally, including in freshwaters, estuaries, oceans, deep sea sediments, coral reefs, mangroves and polar icecaps (Lusher et al. 2017). Microplastics have been demonstrated to have a range of effects on a variety of organisms in laboratory studies encompassing reduced feeding, detrimental effects on organism's health and increased mortality (Cole et al. 2015; Rosenkranz et al. 2009). Evidence of microplastic ingestion has also been reported in organisms in the environment including zooplankton, mussels and fish (Cole et al. 2015; Sanchez et al. 2014; Wegner et al. 2015). Freshwater systems are acknowledged to be a significant input on microplastics into the marine environment, and there is increasing research to address uncertainties in this area (Eerkes-Medrano et al. 2015; Lechner et al. 2015). Although plastic is found universally, there are many differences in the type of plastic (chemical composition), shape and colour found in the environment due to the wide range of uses and sources of plastic (Lusher et al. 2017). The range of plastics has the potential to interact and affect organisms in different ways, and in this study we focused on the effect of colour on plastic ingestion. Colour selectivity in Daphnia magna (a keystone

species) was assessed by exposing the Daphnia to a range of treatments using various coloured polyethylene spheres, including (green, pink, white and clear) and quantifying the uptake based on fluorescence and confocal microscopy measurements, coupled with mass-based analysis for clear and white particles and TEM images of the animals. The treatment exposures included; plastic in the presence of algae (their natural food), pre-treated plastics (that had been given time for an eco-corona to develop following exposure to Daphnia) and various combinations of colour to determine whether there is preferential uptake on the basis of colour at the different size ranges (3-5 μm to match the size of algae, and 10-30 μm where some size discrimination may occur). The colours of the polyethylene in the study were selected to represent the most common colours of plastic found in the environment as reported in the literature and on the basis of availability of the required sizes, with the fluorescent green ones acting as a control matched to the colour of their normal food. The aim was to determine if the colours of the plastic has a significant impact in the preference and therefore uptake of different colour plastics to determine which colours pose the greatest risk. This can then be related back to observations of the most common colours of microplastics found in the environment at different locations or point sources (Mason et al. 2016) to determine the likelihood of ingestion due to the colour preference and availability at those points.

Human-induced diel cycles in stream functioning in Mediterranean WWTP-influenced streams

Susana Bernal (1), Jen Drummond (1), Miquel Ribot (1), Esperança Gacia (1), Anna Lupon (2), Sara Castelar (1), Eugènia Martí (1)

CEAB-CSIC, SPAIN
Presenter: Dr Susana Bernal
Type of Presentation: POSTER

Abstract
Waste water treatment plants (WWTP) can be seen as artificial ecosystems that integrate daily routines of human activity in urban areas. The fingerprint of urban activities influences the diel variation of physicochemical characteristics of WWTP effluents, which is then transferred to the diel dynamics of receiving streams. Yet, the impact of these human-driven diel cycles on stream functioning is largely unknown. The aim of this study was to investigate whether nutrient dynamics and metabolism of WWTP-influenced streams are driven either by the natural diel patterns of light and temperature, or by patterns of urban activity. The study was conducted in a naturally intermittent stream where inputs from WWTP can account up to 100% of stream flow in summer. We measured electrical conductivity, pH, water temperature, light, and dissolved oxygen concentration at 15-minutes intervals in two reaches located upstream and downstream of a WWTP effluent. Moreover, we measured dissolved inorganic nitrogen concentration at 2-hour intervals. The deployments lasted between 6 and 10 days and were repeated once per season. We hypothesize that urban-induced diel cycles in treated waste water

will affect the biogeochemistry and metabolism of the receiving stream and that the magnitude of this effect will depend on stream hydrological conditions which can show large fluctuations between the dry and wet season. This study is still ongoing, and we will be presenting some preliminary results exploring the variability in the measured variables as proxies of metabolism and nutrient uptake, and how they diverge between the upstream and downstream sites. Our approach highlights that WWTP effluents are not only sources of pollutants to streams, but can also induce profound alterations in the intrinsic functioning of freshwater ecosystems and their response to climatic variability.

Stormwater nutrient dynamics during riparian zone saturation and lentic-lotic transition

Tanveer M. Adyel, Matthew R. Hipsey, Carolyn E. Oldham

The University of Western Australia
Presenter: Carolyn E. Oldham
Type of Presentation: POSTER

Abstract
Constructed wetlands (CWs) are ecotechnology for the attenuation of urban stormwater nutrient in order to protect downstream sensitive waterways. However, CWs in the Mediterranean climate can experience extreme flow conditions depending on the season and hydro-meteorology. Water levels in CWs can drop during the dry summer and the systems transition to lotic environments. However, the same CW may receive nutrient-rich stormwater pulses during the wet winter, which transit the systems back into lotic environments. This lotic transition can saturate riparian zone and shorten the hydraulic retention time of the CW. Understanding the impact of periodic lentic-lotic transitions for nutrient dynamics remains challenging and to date this scenario has not been investigated within the context of stormwater treatment CWs. This research aimed to investigate nutrient, particularly nitrogen (N) and phosphorus (P), attenuation or release during riparian zone saturation and lentic-lotic transitions in a meandering surface flow CW on the Swan Coastal Plain in Western Australia. Surface water samples were collected at the inlet and outlet during episodic storm pulses, while soil porewater samples were collected at different depths (0.2, 0.4 and 0.6m from the soil surface) along a 2m riparian transection. Riparian zone saturation after prolonged dry periods released P-based nutrients. Soil porewater showed higher P concentrations than that found in incoming stormwater. Organic-rich riparian sediments also released ammonia (NH3) and filtered oxidized nitrogen (NOx) from their porewater to the overlying water column when the riparian zone flooded with water or when the CW transitioned to a lotic condition. Overall, nutrient loads were attenuated when the CW experienced low-flow lotic conditions, while nutrients were released under high flow lotic conditions. This research also used high resolution dissolved oxygen (DO) measurements to estimate wetland metabolism, and used this as an indicator of CW function; this metabolism indicator was influenced by hydrological and biogeochemical variability within the CW. Water temperature, solar exposure,

antecedent dry days, and water volume and level influenced DO levels, diurnal DO level fluctuations, and ultimately wetland metabolism during the lentic-lotic transitions. Interestingly, positive metabolic activity (as indicated by oxygen fluctuations) was linked with nutrient attenuation when the CW transitioned from a lentic to lotic state. This study enhances our understanding of nutrient cycling in CWs experiencing extreme hydrological variability.

Estimate the Irrigation Water Requirement Threshold via Stochastic Model for Maize Cropping in a Desert Oasis of Northwest China

Hu Liu * Wenzhi Zhao Zhongkai Li

Northwest Institute of Eco-Environment and Resources, Chinese Academy of Sciences
Presenter: HU LIU
Type of Presentation: POSTER

Abstract
Inland river basins occupy nearly 1/4 of the China's total land area, with runoff from the mountains being its only water source. The inland rivers generate many oases in fluvial plains when running out the mountains. Those oasis provide important habitat refugee for plants, animals, and humans alike in northwest China. Water is a critically limited resource in the oases of arid inland basins, it is essential for the development of the socio-economy and the sustainability of eco-environmental systems. When too much water was used by agriculture, ecological suitability is coming as an important issue to be concerned, and thus, determining the threshold is important to balancing the limited water resources for human and nature. During the past decades, water shortage has already become the main restriction for sustainable economic development in this region. Thus, extensive investigation of the water requirements of crops could help improve irrigation water-use efficiency and consequently alleviate the water crisis for those oasis. The aim of this work is to infer the irrigation threshold parameter that connects the ecological and hydrological processes inside eco-hydrological models. A combination of field measurements, continuous monitoring, and numerical modeling were used to evaluate the relationship between water irrigation and productivity in the desert oasis in the Heihe River Basin (HRB). Recorded data of precipitation, irrigation, and floods were used to build the model, and an optimization technique was employed to calibrate the parameters. Based on the optimized parameters and estimates of future scenarios, the modeling structure was employed to determine the irrigation thresholds under climate change and intensive management. We further unscaled the threshold values as a threshold map of desert oasis by coupling the threshold function at point scale with soil data at the regional scale. The results revealed a highly spatial heterogeneous pattern of irrigation threshold at regional scale, indicating an optimized irrigation strategy or increased irrigation techniques would significantly improve the water use efficient, and thus there is a large potential in balancing the water budget and alleviating water stress in this region and other areas of the northwestern China.

THERMAL INFRARED IMAGING FOR DETECTION OF UPWELLING FLUXES IN THE WATER SURFACE

Amaya Irene, Marruedo Arricibita

Leibniz Institute of Freshwater and Inland Fisheries (IGB)
Presenter: Amaya Marruedo
Type of Presentation: POSTER

Abstract
The buoyancy of warm water upwelling during winter and early spring allows for the identification of upwelling related hotspots in surface water using thermal infrared (TIR) imaging. However, although TIR has been successfully used to screen large surface areas of coastal zones, lakes, reservoirs and large rivers for groundwater discharge or thermal pollution monitoring, there is a lack of knowledge regarding the perturbations and signal losses at small scales that occur when monitoring warm water upwelling fluxes with a TIR camera placed well above the water surface. In the present study, warm water upwelling in a surface water body was simulated in a mesocosm experiment. Under winter conditions, water at 14 °C to 16 °C was discharged at the bottom of a 10 x 2.8 x 0.82 m mesocosm where surface water varied from 4 °C – 7.4 °C. For comparions, one layer (80 cm above the sediment) of the mesocosm was equipped with fibre-optic distributed temperature sensing (FO-DTS). TIR imaging was deployed to characterize the spatial distribution of warm water upwelling fluxes at the water surface, with the FO-DTS measurements used for validation. Different warm water injection rates were simulated in order to establish the minimum rate of warm water upwelling that can be reliably detected at the water surface by TIR imaging. Results of the experiments allow us to benchmark scale dependencies and adequacy of TIR imaging. Diurnal temperature cycles as well as the weather conditions (clear versus overcast) affect the performance of the method. The operational capabilities of the TIR camera are affected by the degree of temperature variation during the diurnal cycle resulting in different intensities of the lens distortion effect on the raw TIR images

SCALING OF WATER AND HEAT FLUX/EXCHANGE PROCESSES IN FRESHWATER ENVIRONMENTS BASED ON TEMPERATURE TRACERS

Amaya I. Marruedo Arricibita, Jörg Lewandowski, Stefan Krause, David M. Hannah and Aaron Packmann.

Leibniz Institute of Freshwater and Inland Fisheries (IGB)
Presenter: Amaya Marruedo
Type of Presentation: POSTER

Abstract
Water and heat fluxes in freshwater environments across different interfaces can be traced on different space and time scales by heat tracing techniques such as single point temperature sensors, temperature lances, fiber optic distributed temperature sensors (FO-DTS) and thermal InfraRed imaging (TIR). Up to date most research

mainly described, tested and benchmarked the above mentioned techniques in different environments and on single scales. However, there are gaps in the scale continuum when characterizing water and heat fluxes in freshwater environments. Each heat tracing technique included in the present study is generally best for one specific scale. None of them is able to monitor water and heat fluxes across the complete scale continuum. The scale on which the measurements are conducted deeply affects the interpretation of the measurements: Processes and parameters relevant on one scale might not be as relevant or predictive on another scale. For this reason, limitation of monitoring campaigns to one single device at a specific scale leads to incomplete observations and biases in the processes and patterns described. In fact, recently lots of papers combine multiple technologies/approaches in order to overcome data gaps of the scale continuum. However, there is an imbalance between measurements and process understanding. It is not clear yet how well the available scaling theories can be applied to multi-scale water/heat exchange processes in freshwater environments. The present study proposes a conceptual design based on hierarchical patch dynamics (HPD) theory to describe heat and water exchange processes over several scales in freshwater environments. This conceptual design would guide the researcher on how to combine different heat tracing techniques adequately across the scale continuum to get the best picture of the process under study.

Modelling soil temperatures in grassland ground mounted solar photovoltaic parks

Maria Makaronidou[1], Alona Armstrong[1], Nicholas Kettridge

Lancaster University
Presenter: Maria Makaronidou
Type of Presentation: POSTER

Abstract
In the UK, solar photovoltaic (PV) panels are primarily installed on grasslands which provide us with many ecosystem services. The effect of solar PV parks on the soil and air climate and soil properties is poorly resolved, despite the potential implications for ecosystem function. Soil temperature is a crucial parameter affecting among others soil properties, plant growth, vegetation cover and is expected to be influenced by ground – mounted solar PV arrays. In this study, we will investigate our hypothesis by testing a two-dimensional model, to simulate soil temperatures in a solar PV park in Oxfordshire, UK. The model uses standard meteorological data, soil properties and PV array dimensions to simulate soil temperature. We validate the model with temporally and spatially explicit soil temperature data. We test our models in different climatic periods occurring in 2015 and investigate whether different microclimatic events (extreme high and/or low air temperature, high volume of precipitation, drought, cloudiness etc.) will have a significant effect on model error. The models will provide us with soil temperature simulations along a transect covering areas under and in the gap between the panel rows. Two periods have been tested so far (highest temperatures and zero precipitation), and illustrated an adequate simulation. The models will be further tested using data from different size and design of the PV panel under different soil properties, vegetation cover and surface resistance (in terms of evaporation). It is therefore crucial to evaluate the size of potential future impacts of solar PV arrays in different park designs, under different soil properties, climates and vegetation cover to optimise grassland management. Keywords: solar PV park, grasslands, 2D soil temperature simulation model, soil properties, vegetation cover, surface resistance

Using intrinsic diurnal concentration fluctuations in an urban lowland stream to investigate transport and fate of organic micropollutants based on the one-dimensional transport model OTIS

Jaeger, Anna (1,2); Posselt, Malte (3); Schaper, Jonas (1,4); Lewandowski, Jörg (1,2)

Leibniz-Institute of Freshwater Ecology and Inland Fisheries, Department Ecohydrology, Berlin, Germany
Presenter: Anna Jaeger
Type of Presentation: POSTER

Abstract
Tracking the transport of emerging contaminants in rivers is challenging. Often, artificial tracers are injected into the stream water to capture single water parcels in a Lagrangian-sampling concept. In the present study, intrinsic diurnal fluctuations of conservative wastewater-derived substances are used as tracers for solute transport along a 4.7-km stretch of River Erpe in Berlin, Germany. That river, a typical urban lowland stream, receives discharge from a wastewater treatment plant in daily pulses causing the diurnal fluctuations. Water samples were collected once per hour for two days at different locations downstream of the wastewater inflow to capture two of the daily signals. The samples were analysed for a set of wastewater derived pharmaceuticals and personal care products as well as related transformation products. Simultaneously, data loggers installed in the stream at the respective locations recorded water levels, temperatures and electric conductivities. The measurement campaign was conducted three times: once in April and twice in June, before and after a stretch of the river has been cleared of macrophytes. This way, a variety of seasonal and hydrological conditions were covered. The resulting data are implemented in a one-dimensional transport with inflow and storage model (OTIS). Electric conductivity was used to estimate hydrological parameters, such as the cross-sectional area of the main channel and the transient storage zone, dispersion coefficient and the storage zone exchange coefficient. The parameters vary with discharge and abundance of macrophytes. In a second step, OTIS is applied to concentration time series of reactive compounds to estimate the first-order decay coefficients and the sorption rates. The compounds show individual behaviour along the reach, ranging from degradation to formation (transformation products).

Sorption of carbamazepine, diclofenac, ibuprofen, metoprolol and sulfamethoxazole to sediment from river Erpe, Berlin

Muhammad Raza (1), Christine Kuebeck (1), Christoph Schueth (1,2)

IWW Water Centre
Presenter: Muhammad Raza
Type of Presentation: POSTER

Abstract
Sorption is expected to be one of the main factor influencing the fate of pharmaceuticals in sediment, beside microbial degradation processes. Some of the pharmaceuticals of concern include carbamazepine, diclofenac, ibuprofen, metoprolol and sulfamethoxazole originated from insufficient treatment of wastewater released into the river. Sediment and water samples from Erpe river, Heidemühle, Berlin were collected in June 2016 to study the sorption processes of the selected pharmaceuticals into hyporheic river sediment. Two grams of air-dried sediment samples were added into 10 mL of mixed solution in glass amber bottles. Mixture of the pharmaceutical compounds were spiked into the solution to produce a final concentration of 0.1, 0.5, 1, 10 & 20 mg/L in triplicates. A control solution without added sediment act as the reference. The sediment and solution were

continuously mixed on an orbital shaker for 48 hours at room temperature. The results of batch kinetic adsorption study revealed that these pharmaceuticals achieve equilibrium within 48 hours. Adsorption of the pharmaceuticals onto the sediment particles were calculated using the initial and final pharmaceutical concentrations measured by high performance liquid chromatography (HPLC). The adsorption isotherms were measured using the Freundlich equations and relationship between the sorption coefficients and soil properties were evaluated using Pearson product moment correlation. High organic carbon content in riverine surface sediment was determined to be the main factor governing the sorption processes of pharmaceuticals to the sediment.

Surveillance of pathogenic enteric viruses at freshwater/seawater interfaces as complementary indicators of water quality

Gonçalves José (1-2), Gutierrez-Aguirre Ion (2), Balasubramanian MN (3), Kovac K (3), Hren M (3), Ravnikar M2, Turk V (1)

National Institute of Biology, Slovenia
Presenter: José Manuel Carita Gonçalves
Type of Presentation: POSTER

Abstract
Estuaries are environments with strong gradients, resulting from a mixture of fresh and marine waters that often correlate with enhanced rates of biogeochemical processes with impact on microbial dynamics, community composition and ecosystems productivity. In the current study, seasonal changes in physicochemical and biological parameters were studied at the highly stratified and organically polluted Rižana estuary, located in the northern-eastern part of the Gulf of Trieste (North Adriatic Sea, Slovenia). Water samples for nutrient analysis, microbial abundance of viruses and bacteria, bacterial carbon production and bacterial community composition were collected along the estuary, from the river Rižana to the middle of the Koper Bay. The flux of matter from terrestrial to marine environments and the proximity with waste water treatment discharges boost the transport of pathogens into marine ecosystems. Traditionally, microbial quality of waters has been assessed by detecting faecal indicator bacteria (FIB), however, previous studies demonstrated that FIB have a poor relationship with non-bacterial pathogens, especially with the presence of human enteric viruses. Rotavirus (RoV) and Norovirus (NoV) are among the most prevalent enteric human viruses in polluted areas and they are the main agents of human viral gastroenteritis worldwide. In the current study, a protocol to concentrate RoV and NoV from coastal waters with different salinity concentrations using CIM columns was developed and applied, prior to detection by one-step RT-qPCR. Our study concluded that CIM C4 hydrophobic interaction monolithic supports efficiently bind and concentrate RoV and NoV from water samples in one step and their performance is consistent in seawater and brackish water. A survey was made at the Koper Bay for RoV and NoV during a period of one year. RoV and NoV were detected in the studied area, with higher detection rates close to the wastewater treatment

discharge, but they were also sporadically detected at recreational waters and mussel farming areas. Our study supports the idea that water bodies that are considered safe based on bacterial concentrations, may still have low, yet infective, concentrations of human viruses and direct measurement of RoV and NoV can be an important complementary parameter assessing the water quality. Moreover, there were significant changes in bacterial community composition along the salinity gradient.

Widened range of water chemistry compounds and leached humic substances from drained peatlands of Estonian Mustjõgi stream catchment.

[1]Iti-Kärt Kiivit, [2]Elve Lode, [1]Rando Tuvikene.

Tallinn University
Presentor: Iti-Kart Kiivit
Type of Presentation: POSTER

Abstract

Chemistry of peatland discharges has been studied extensively in many peat covered countries since the mid-twentieth century. Study of Central Sweden catchments show runoff increment of drained bog area 13-61% in comparison with the pre-drainage period. Nitrogen leaching increment was 34%. Study results from the Northern Finland show significantly varying seasonal leaching of total nitrogen and phosphorus, - ranging from 0.7 to 12.8 kg (N/ha/y) and from 0.04 to 0.77 kg (P/ha/y) correspondingly.

Our study was performed in Mustjõgi stream catchment, belonging to the Endla mire complex in Central-East Estonia. An intensive water sampling and analysis of wider range of water chemistry compounds and leached humic substances has been carried out at four sub-catchment outlets and at two gouging stations of Mustjõgi stream (including one Mustjõgi-Tulijärve state monitoring station) during 2014-2015. Sample collections took place under varying weather conditions, in average two times per month. For analyses of all collected samples we used the High Performance Liquid Chromatography (*HPLC*) at analytical chemistry laboratory of TLU. We analysed concentrations of ten basic ions and humic substances. Preliminary results of means of analysed bog sub-catchments basic ions for fluoride was 0.2 mg/L, chloride - 0.9 mg/L, sulphate - 0.5 mg/L, nitrate - 2.4 mg/L, nitrite - 0.2 mg/L, ammonia - 0.3 mg/L, sodium - 0.7 mg/L, potassium - 1.0 mg/L, magnesium - 0.2 mg/L and calcium - 3.4 mg/L. The humic substances mean concentration was 62.0 mg/L. Those bog sub-catchments should be taken as a reference to the Mustjõgi stream catchment, - carrying the loads from the drained peatland forest with recently cleaned ditches on the upper stream.

Analysis of the Mustjõgi-Tulijärve gouging station data revealed an annual means for the N_{tot} and P_{tot} loads 1.9 kg N/ha/y and 0.09 kg P/ha/y for the period 1995-2006. Range of anions concentrations during our sampling period at Mustjõgi-Tulijärve station for fluoride varied from 0.2 to 2.3 mg/L, chloride from 3.6 to 5.0 mg/L, sulphate from 3.2 to 5.7 mg/L, nitrate from 1.1 to 4.9 mg/L, nitrite from 0.4 to 0.6 mg/L, ammonia from 0.06 to 0.3 mg/L, sodium from 1.4 to 3.1 mg/L, potassium

from 1.5 to 3.8 mg/L, magnesium from 9.5 to 17.6 mg/L and calcium from 57.9 to 92.7 mg/L. The humic substances varied from 36.7 to 60.0 mg/L.
Comparison of gathered results shows that there are four important chemical ingredients which have significant importance for the discharged water of the bog sub-catchments: chloride, nitrate, ammonia and humic substances. At the same time along the Mustjõgi stream, relatively significant changes toward increment took place for fluoride and sulphate concentrations, and toward decrement – ammonia, sodium, potassium, humic substances.

Abundance, characterisation and potential impact of microplastic debris in a UK canal system

Rebecca Adams, Iseult Lynch and Jon Sadler

University of Birmingham
Presentor: Rebecca Adams
Type of Presentation: POSTER

Abstract
Microplastics (MPs), widely defined as plastic debris <5 mm in length (Thompson, 2015), are of global, environmental concern due to their persistence and prevalence in natural environments. To date, MPs have been detected in numerous marine habitats, such as Artic Sea ice (Obbard et al., 2014), and deep-sea sediment (Van Cauwenberghe et al., 2013), and a wide array of marine organisms, ranging from microscopic zooplankton (Cole et al., 2013) to whales (Lusher et al., 2015). Whilst MPs have been well documented in the marine environment, little is known about their behaviour and potential impacts in freshwaters despite the suggestion that rivers may be a major source of MPs to the open ocean (Eerkes-Medrano et al., 2015). There is thus an urgent need to address freshwater knowledge gaps by assessing the occurrence, fate and impacts of both MPs and even smaller plastic items, termed nanoplastics (NPs), in selected freshwater systems. In this study, MPs were separated from sediment and surface water samples taken from the Worcester and Birmingham Canal, UK. MPs were then counted and subsequently categorised by polymer type, plastic type and size. Using the Biolog® multiwell plate technology, selected and sorted (by size, colour, shape and density) MPs were exposed to freshwater microbial communities typically found in either sediment or water column habitats to ascertain whether the microorganisms could survive, metabolise and potentially degrade the MP polymers. Selected MPs were also exposed to chemical contaminants, e.g. plasticizers, insecticides, and then included in the assay to investigate any synergistic effects of plastic and co-contaminant. By analysing MP abundance in sediment and water samples, we can determine if sediment acts to retain MPs, thus limiting the amount of MPs that could be introduced to other freshwater environments. Additionally, we can also determine the effect of MPs on sediment-specific or water column-specific freshwater microbial communities and determine their potential impact on the fate of MPs in the environment. Keywords: Microplastic, Nanoplastic, Freshwater, Microbial community References Cole, M., Lindeque, P., Fileman, E., Halsband, C., Goodhead, R.,

Moore, J. and Galloway, T. S. (2013) 'Microplastic ingestion by zooplankton', Environmental Science and Technology, 47(12), pp. 6646-6655. Eerkes-Medrano, D., Thompson, R. and Aldridge, D. C. (2015) 'Microplastics in freshwater systems: A review of the emerging threats, identification of knowledge gaps and prioritisation of research needs', Water Research, 75, pp. 63-82. Lusher, A. L., Hernandez-Milian, G., O'Brien, J., Berrow, S., O'Connor, I. and Officer, R. (2015) 'Microplastic and macroplastic ingestion by a deep diving, oceanic cetacean: the True's beaked whale Mesoplodon mirus', Environmental Pollution, 199, pp. 185-191. Obbard, R. W., Sadri, S., Wong, Y. Q., Khitun, A. A., Baker, I. and Thompson, R. C. (2014) 'Global warming releases microplastic legacy frozen in Arctic Sea ice', Earth's Future, 2(6), pp. 315-320. Thompson, R. C. (2015) 'Microplastics in the marine environment: Sources, consequences and solutions', In: Bergmann, M., Gutow, L. and Klages, M. (ed.) Marine Anthropogenic Litter. Place: publisher, 185-201. Van Cauwenberghe, L., Vanreusel, A., Mees, J. and Janssen, C. R. (2013) 'Microplastic pollution in deep-sea sediments', Environmental Pollution, 182, pp. 495-499.

The effect of non-steady overlying water velocity on oxygen and carbon dioxide consumption under losing and gaining conditions

Jason Galloway Liwen Wu Joerg Lewandowski Shai Arnon
Leibniz-Institute of Freshwater Ecology and Inland Fisheries
Presentor: Jason Galloway
Type of Presentation: POSTER

Abstract
Wastewater treatment plants which discharge treated effluent into river systems can drastically alter downstream flow regime from steady velocities, to velocities which fluctuate on a diurnal cycle increasing by as much as 2-fold. Although the importance of surface flow velocity as a key driver of small-scale hyporheic exchange is well understood, the effects of unsteadiness in flow velocity on the delivery and dynamics of solutes such as oxygen and nutrients is poorly understood. Flow variations are expected to have complex and non-linear impacts on the temporal and spatial redox dynamics within the hyporheic zone. The objective of the current study is to quantify the effect of non-steady flow on oxygen consumption and carbon dioxide production under losing and gaining conditions. The experiments are conducted in a novel system which allowed for precise control and modulation of overlying flow velocities and losing/gaining fluxes. The flume is 260 cm-long by 29 cm-wide flume and packed with natural sand from a stream that regularly receives treated wastewater. Two sinusoidal functions, based on observations from the River Erpe in Germany, were used to alter flow velocities. Experiments were carried out under neutral, up- and down-welling conditions. Oxygen and carbon dioxide dynamics were investigated by using planar optodes to measure their concentrations in the hyporheic zone at a high temporal and spatial resolution. The experimental results were then used as inputs for a reactive transport model allowing for the calculation of oxygen and carbon dioxide consumption and production rates. Experiments conducted under steady flow were used as a baseline with which to compare the impact of unsteady flow. A complex

interplay between direction and magnitude of surface water velocity change as well as antecedent flow conditions was discovered and quantitatively described. The development and calibration of the model allowed the authors to explore the relationships discovered under a variety of in a variety of scenarios, such as for different sediment grain sizes and discharge regimes to increase the robustness and applicability of the findings. Overall, unsteady flow conditions lead to an increased delivery of dissolved oxygen to the hyporheic zone and lead to a higher rate of oxygen consumption than would have been predicted by a comparable steady surface flow. The results of the current study provide an insight into how anthropogenic changes to discharge regimes in river systems can impact the biogeochemistry of the hyporheic zone. These results are important for researchers designing experiments and simulations to predict the fate of redox sensitive compounds and also for practitioners when making river management decisions.

Current and future partition of evaporation and transpiration in Alpine Environments

Natalie Ceperley (1) Joshua Larsen (1,2) Anthony Michelon (1) Harsh Beria (1) Bettina Schaefli (1)

University of Lausanne, Switzerland
Presenter: Joshua Larsen
Type of Presentation: Poster

Abstract
Alpine environments are simultaneously home to the headwaters of most of the world's rivers and likely to experience dramatic changes in their physical and biological environment due to climate change. Additionally, because of the high level of topographical complexity producing a plethora of microclimates that are difficult to predict and the challenge of measurement in high elevation environments, scientific knowledge of alpine environments is incomplete. For example, tree lines are currently observed to be rising, and are expected to continue extend higher in the mountains. Thus, the area occupied by vegetation is expanding and potentially modifying the influence of evapotranspiration (ET) within alpine water balances. Secondly, the absolute rates of evapotranspiration are expected to increase in alpine areas due to the warmer climate, specifically feedbacks between warming air, changes in vapour pressure deficit and moisture transport processes. In addition, feedbacks also exist between the change in area of forest cover and change in rate of ET, which include processes related to the change in roughness and change in albedo. Such changes will affect the entire water balance including run-off and groundwater recharge. Predicting feedbacks between changes in vegetation and climate is challenging due to the complexity of the hydro-ecological processes. In this presentation we will discuss current knowledge of how rates of evaporation and transpiration are expected to change with the interrelated consequences of climate and land use change in alpine environments and shed light on the answers to the open questions based on our data from the Swiss Alps (Vallon de Nant, Vaud).

PHYTOPLANKTON ASSEMBLAGE AND PHYSICOCHEMICAL PARAMETERS OF A PERTURBED TROPICAL MANMADE LAKE, SOUTHWESTERN NIGERIA

1. Adedolapo Ayoade 2. Joohn The Beloved Dada

University of Ibadan, Ibadan, Nigeria
Presenter: Dr Adedolapo Ayoade
Type of Presentation: POSTER

Abstract:
This study identified the phytoplankton assemblage of the Dandaru Lake (that received effluents from a zoological garden and hospital) as bioindicators of water quality. Physicochemical parameters including Dissolved Oxygen (DO), biochemical oxygen demand, nitrate, phosphate and heavy metals were also determined. Samples of water and plankton were collected once monthly from April to September, 2015 at five stations (I – V). The mean physicochemical parameters were within the limits of National Environmental Standards and Regulations Enforcement Agency (NESREA) and USEPA except Lead, 0.02 ± 0.08 mg/ L; Manganese, 0.46 ± 1.00 mg/ L and Zinc, 0.05 ± 0.17 mg/ L. Means of DO, alkalinity and phosphate were significantly different between the stations at $p < 0.05$. While highest mean DO (6.88 ± 1.34 mg/L) was recorded in station I with less anthropogenic activities, highest phosphate concentration (0.28 ± 0.28 mg/L) occurred in station II, the entry point of wastewater from hospital and zoological garden. The 147 phytoplankton species found in the lake belonged to six classes: Chlorophyceae (50), Euglenophyceae (40), Bacillariophyceae (37), Cyanophyceae (17), Xanthophyceae and Chrysophyceae (3). The order of abundance for phytoplankton was Euglenophyceae (49.77%) > Bacillariophyceae (18.00%) > Cyanophyceae (17.39%) > Chlorophyceae (13.7%) > Xanthophyceae (1.06%) > Chrysophyceae(0.02%). The stations impacted with effluents were dominated by members of Euglenophyceae (Station III, 77.09%; IV, 50.55%) and Cyanophyceae (Station II, 27.7%; V, 32.57%). While station I was dominated by diatoms (57.98%). The species richness recorded was 0.32 – 4.49. Evenness index was highest in station I and least in station III. Generally, pollution tolerant species (Microcystis, Oscillatoria, Scenedesmus, Anabaena, and Euglena) showed greater density in areas impacted by human activities. The phytoplankton assemblage and comparatively low biotic diversity in Dandaru Lake could be attributed to perturbations in the water column that exerted selective effects on the biological assemblage. Keywords: Phytoplankton, Water quality, Dandaru Lake, Nigeria

Risk-Benefit Quantification of Floodwater Resources Utilization

Huang Xian-feng , Fang Guo-hua, Zhu Lixiang

Hohai University
Presenter: Dr Huang Xianfeng
Type of Presentation: POSTER

Abstract

This paper combines the risk factors of floodwater resources utilization to quantify the risk-benefit of floodwater resources after adjusting limit water level. The limit water level is a key level involved the flood risk and benefits of the reservoir. After adjustment of limited water level, each risk rate correspond to each water level is obtained. Proportional distribution of increasing water content after adjusting the flood control level. Risk-benefit is comprehensive considered including industry, agriculture, life and ecology. The four benefits are quantified by C-D production function, the sharing coefficient method, water price based on energy and the energy theory. This paper took Shilianghe reservoir of Lianyungang City as the research case. Risk rates and benefits of each limit water level are calculated. Under the conditions of minimum risk and maximum benefits, the result that the control range of the limit water level is 23.9m~24.9m at Shilianghe reservoir can be obtained according to the relationship between the limit water level, risk rate and risk benefit.

ENSURING A BETTER FUTURE FOR WATER IN THE DEMOCRATIC REPUBLIC OF CONGO
CASE ; kasai river

PHILIPPE MABIALA DALY KIALA NKABU

Official journal of Democratic Republic of Congo
Presenter: VALENTIN TEMBE MWELA
Type of Presentation: POSTER

Abstract

The Democratic Republic of Congo has great potentials in water resources and ecosystems whose management, protection and valorization depend on new challenges incurred by sustainable development, fight against poverty and climate change. On another hand, the people's access to drinking water still is challenge. It is thus necessary to adopt new policies and efficient management schemes at both the water resource and the public service level ; to valorize water, to ensure better for it future, not only as an economic resource but also as a social asset, since one of the essential roles of water is the preservation of life. To ensure a better future for water in the Democratic Republic of Congo, the national assembly and the senate have adopted law n°15/026 of december the 31st 2015. And this law has found ground in articles 9 and 48 of the constitution. Its has also included dispositions from article 203, point 16, and article 204, point 26, relating to competing constitutional competences and those devolved exclusively to the provinces provided it meets the universal principles of water resources management and public service. The following objectives were pursued: • Meet the prescribed obligation of the state, articles 9 and 45 of the Constitution as referred to above; • Establish the liability rules related to the water public sector and sanitation by adapting them to current requirements of economic and social development in the country. • Determining the necessary instruments for a rational and balanced management of water patrimony, following a multi-sectoral approach that takes

into account the present and future needs; • Resolving the problem of inadequate legal and institutional framework as well as the low rate of access to drinking water; • Determining the necessary instruments for a rational and balanced management of water patrimony, following a multi-sectoral approach that takes into account the present and future needs; • Resolving the problem of inadequate legal and institutional framework as well as the low rate of access to drinking water; • In addition it also strengthened, in a particular way, requirements related to an environmental and social impact study, prior to concession granting and sampling of water resources. It established a legal regime based on declaration, authorization and concession. It also introduced the principle of consulting the Congolese people by referendum prior to all freshwater transfer outside the national territory. • • SCIENTIFIC RESULTS Physico-chemical parameters (PH, electric conductivity, temperature) are measured ; Major ions (anions and cations) that were assayed ; The collected water level. KASAI RIVER (DIMA) Table I DATE CAMPAIGN HOUR PH CONDUCTIVITY T° (°C) O2 15/12/2016 21 9H04 10,025 28,3 29 4,53 ou 60,5% NO3 mg/l PO4 mg/l NO2 mg/l SO4 mg/l CO2 mg/l Alk mg/l SECHI cm 4,5 0,36 0,021 1,6 16,5x2 7,5 40

Integrating root dynamics into Noah-MP for modeling desert phreatophytes

Ping Wang 1 Guo-Yue Niu 2, 3 Yuan-Hao Fang 4 Jing-Jie Yu 1 Guo-Fu Yuan 5

Institute of Geographic Sciences and Natural Resources Research, CAS
Presenter: Dr Ping Wang
Type of Presentation: POSTER

Abstract
Plants' optimality through adjusting their root systems is a way for plants to adapt to harsh environments. However, most existing land surface models (LSMs) use a prescribed, static root profile, which cuts the interactions between soil moisture and root dynamics. In this paper, we implement an optimality-based model of root dynamics that is capable to adapt to soil moisture dynamics in meeting the water demand for plant transpiration into the Noah-MP LSM. The dynamic root model updates its vertical profile of the root surface area in conjunction with changes in the water stored in plant tissues and the soil moisture profile. Considering direct water uptake by roots from the matrix saturation zone above the water table and the underlying saturated zone, we introduced a "watered" root layer into the Noah-MP scheme to represent the overall root density within these two zones. We have tested the model against observations of a riparian Tamarix spp. stand under a hyper-arid climate (approximately 35 mm precipitation per year) in northwestern China. Compared with the original, static root profile, the dynamic root model significantly improves the energy and water flux simulations from the groundwater-soil-plant system to the atmosphere, particularly during the dry seasons. The improved model with root dynamic provides a powerful framework to understand and predict the responses of groundwater-dependent terrestrial ecosystems to climate change and groundwater extraction in arid and semi-arid regions.

China system of environmental and economic accounting for water

ZHANG Hai-tao

Institution: N/A
Presenter: Mr Zhang Haitao
Type of Presentation: POSTER

Abstract
Water is a crucial resource and environment factor, and water resource accounting is an important issue of comprehensive environmental economic accounting. The method of comprehensive environmental economic accounting, which offers the basic framework of water resource and environment accounting, is based on national economic accounting. The basic objective of environmental and economic accounting for water resources is to set up an accounting system from the perspective of the economic system and to provide systematic data to reflect the cycle of water in the economic system and the relationship with the natural water cycle, and reflect the contribution of the economic system to the development, utilization, management and conservation of water resources, and also offer systematic information on water resources support to the economic system and the impact of economic systems on water resources, serving for the integrated water resources management. To be more specific, the water resources value can be imported into the national property accounting, the cost of water consumption and water environmental degradation can be imported into GDP accounting, and the fully assessed value of the supply of water resources can be imported into economic accounting, etc. And based on the water resources accounting system of United Nations and integrated environmental and economic accounting of China, the framework of environmental accounting of China for water resources can be proposed. Framework system consists of three aspects: (1) Water resources physical accounting (2) Water economic accounting (3) Comprehensive accounting of water

Analysis of Long-Term Water Level Variation in Dongting Lake, China

Qiaoqian Han Guoxian Huang

China Institute of Water Resources and Hydropower Research
Presenter: Prof Shuanghu Zhang
Type of Presentation: POSTER

Abstract
The water level of Dongting Lake has changed because of the combined impact of climatic change and anthropogenic activities. A study of the long-term statistical properties of water level variations at Chenglingji station will help with the management of water resources in Dongting Lake. In this case, 54 years of water level data for Dongting Lake were analyzed with the non-parametric Mann–Kendall trend test, Sen's slope test, and the Pettitt test. The results showed the following: (1) Trends in annual maximum lake water level (WLM), annual mean lake water level (WL), and annual minimum lake water level (WLm) increased from 1961 to 2014;

however, the three variables showed different trends from 1981 to 2014; (2) The annual change trends in Dongting Lake between 1961–2014 and 1981–2014 were found to be from approximately 0.90 cm/year to ´2.27 cm/year, 1.65 cm/year to ´0.79 cm/year, and 4.58 cm/year to 2.56 cm/year for WLM, WL, and WLm, respectively; (3) A greater degree of increase in water level during the dry season (November–April) was found from 2003 to 2014 than from 1981 to 2002, but a smaller degree of increase, even to the point of decreasing, was found during the wet season (May–October); (4) The measured discharge data and numerical modeling results showed the operation of Three Gorge Reservoir (TGR) pushed to in?uence partly the recent inter-annual variation of water level in Dongting Lake region, especially in the ?ood and dry seasons. The analysis indicated that the water level of Dongting Lake has changed in the long term with decreasing of range between WLM and WLm, and may decrease the probability of future drought and ?ood events. These results can provide useful information for the management of Dongting Lake.

Water use sources of typical sand-fixing plants in northeastern China assessed with d2H and d18O

Zhimin Liu, Baoqing Liu

Institute of Applied Ecology, Chinese Academy of Sciences
Presenter: Dr Zhimin Liu
Type of Presentation: POSTER

Abstract
Introduction The maintenance and functions of sand-fixing vegetation strongly depend on the water use strategies and water use efficiency of selected species. However, how water use strategies differ among species inhabiting different habitats and belonging to varied life forms has been rarely explored in some regions. Here, we reported water use sources of typical sand-fixing plants in northeastern China with d2H and d18O. Methods During the dry season (May) and rainy season (July) of 2016, 12 plant species inhabiting two contrasting habitats, fixed sand dune and interdune lowland, were selected (8 species on fixed dune, including 3 tree species Pinus sylvestris var. mongolica, Populus ssp, Ulmus pumila, 3 shrub species Salix linearistipularis, S. microstachya, Caragana microphyla and 2 herbs Artenmisia gmelinii, Pennisetum centrasiaticum, and 5 species in interdune lowland, including 3 shrub species Salix gordejevii, Caragana microphyla, C. Korshinskii and 2 herbs Hedysarum fruticosum, Artemisia halodendron) in Inner Mongolia, northeastern China. Samples of soil, stem/crown, rainfall and groundwater were collected, and d2H and d18O of each sample were determined in an isotope ratio mass spectrometer. Results and Conclusions In the dry season, species inhabiting interdune lowland mainly used deep soil water (50-150 cm) and groundwater except for grass Pennisetum centrasiaticum, while plants on fixed dune mainly used the soil water in shallow layers (10-50 cm). However, in the rainy season, most plants relied on precipitation. In terms of plant life forms, in the dry

season, shrubs mainly used surface soil water (0-10 cm) with relatively high water content on fixed dune, while in the rainy season, soil water was still the most important source for tree species Ulmus pumila and shrub Salix linearistipularis in interdune lowland regardless of rainfall events. As a whole, the water use depths of species inhabiting the fixed sand dune were deeper than those species in the interdune lowland. Our results indicate that plant water use might be related to the availability of soil water, plant life forms and the habitats they inhabited.

Novel high resolution nitrate isotope method for determination of nutrient fate in aquatic systems

Sophie Comer-Warner, Stefan Krause, Daren Gooddy, Sarah Bennett, Sarah Wexler, Jan Kaiser

University of Birmingham
Presenter: Sophie Comer-Warner
Type of Presentation: Poster

Abstract

The fate of nitrate transported and transformed across groundwater-surface water interfaces has been intensively studied over the past few decades. The interfaces between aquifers, and rivers or lakes, have been identified as biogeochemical hotspots with steep redox gradients. However, a detailed understanding of the spatial heterogeneity and potential temporal variability of redox reactive hotspots at those interfaces, and the consequences for nitrogen processing, is still hindered by a paucity of adequate measurement techniques. A novel methodology is presented here, using Diffusive Equilibrium in Thin-film (DET) gels as high spatial resolution passive samplers of d15NNO3 and d18ONO3 to investigate nitrogen processing. Fractionation of d15NNO3 and d18ONO3 during diffusion of nitrate through the DET gel was determined using varying equilibrium times and nitrate concentrations. The fractionation experiments demonstrated that nitrate isotopes of d15NNO3 and d18ONO3 do not fractionate when sampled with a DET gel. d15NNO3 values from the DET gels ranged between 2.3±0.2 and 2.7±0.3‰ for a pure KNO3 stock solution value of 2.7±0.4‰, and d18ONO3 values ranged between 18.3±1.0 and 21.5±0.8‰ for a pure KNO3 stock solution of 19.7±0.9‰. Nitrate recovery and d15NNO3 and d18ONO3 values were independent of both equilibrium time and nitrate concentration.

Prediction for the stability of the hydro-ecological system of Qinghai Lake

Jia Liu, Fang Wang, Chuanzhe Li, Fuliang Yu

China Institute of Water Resources and Hydropower Research
Presenter: Dr Jia Liu
Type of Presentation: POSTER

Abstract

Qinghai Lake is the largest inland salt lake in China, which is located in the northeast of Tibetan Plateau. In the recent years, Qinghai Lake has been facing a series of eco-environmental problems with close connection to the increasingly reduced quantity of water, including the continuous decline of the water level, the shrinkage of the lake area and the reduction of the biomass of species, which has been threatening the health and stability of the ecosystem of Qinghai Lake. In this study, Qinghai Lake and its lakeside wetlands are treated as a whole to study the hydro-ecological system. On the basis of analysing the status and the interdependent relationship of the biotic populations in the hydro-ecological system of the lake and the lakeside wetlands, the key species of the hydro-ecological system is determined as the Naked Carps. According to an acute salinity-tolerance experiment, a salinity threshold of the Naked Carps is concluded, which can be treated as an indicator of the stability of the hydro-ecological system. Then the lowest stability water level is calculated according to the relationship between the salinity and the water level of lake. Prediction of the monthly water level is also carried out based on a stochastic hydrological model combined with a tendency modification method under dry-and-warm climatic conditions. Results show that although the water level will be still on its decline in the near future, after the year of 2030 it will begin to become stable after a short period of increase. During the periods before the water level becomes stable, the predicted water level is still much higher than the lowest stability level. In that case, a conclusion can be made that the hydro-ecological system of Qinghai Lake may not be affected without water supplement from other regions. Key words: Qinghai Lake, hydro-ecological system, the lowest stability water level, key species, prediction.

Applications of high resolution rainfall radar data to quantify water temperature dynamics in urban catchments

Danny Croghan Anne Van Loon Chris Bradley Jon Sadler David Hannah

University of Birmingham
Presenter: Danny Croghan
Type of Presentation: POSTER

Abstract

Studies relating rainfall events to river water quality are frequently hindered by the lack of high resolution rainfall data. Local studies are particularly vulnerable due to the spatial variability of precipitation, whilst studies in urban environments require precipitation data at high spatial and temporal resolutions. The use of point-source data makes identifying causal effects of storms on water quality problematic and can lead to erroneous interpretations. High spatial and temporal resolution rainfall radar data offers great potential to address these issues. Here we use rainfall radar data with a 1km spatial resolution and 5 minute temporal resolution sourced from the UK Met Office Nimrod system to study the effects of storm events on water temperature (WTemp) in Birmingham, UK. 28 WTemp loggers were placed over 3 catchments on a rural-urban land use gradient to identify trends in WTemp during extreme events within urban environments. Using GIS, the catchment associated

with each logger was estimated, and 5 min. rainfall totals and intensities were produced for each sub-catchment. Comparisons of rainfall radar data to meteorological stations in the same grid cell revealed the high accuracy of rainfall radar data in our catchments (<5% difference for studied months). The rainfall radar data revealed substantial differences in rainfall quantity between the three adjacent catchments. The most urban catchment generally received more rainfall, with this effect greatest in the highest intensity storms, suggesting the possibility of urban heat island effects on precipitation dynamics within the catchment. Rainfall radar data provided more accurate sub-catchment rainfall totals allowing better modelled estimates of storm flow, whilst spatial fluctuations in both discharge and WTemp can be simply related to precipitation intensity. Storm flow inputs for each sub-catchment were estimated and linked to changes in WTemp. WTemp showed substantial fluctuations (>1 °C) over short durations (<30 minutes) during storm events in urbanised sub-catchments, however WTemp recovery times were more prolonged. Use of the rainfall radar data allowed increased accuracy in estimates of storm flow timings and rainfall quantities at each sub-catchment, from which the impact of storm flow on WTemp could be quantified. We are currently using the radar data to derive thresholds for rainfall amount and intensity at which these storm deviations occur for each logger, from which the relative effects of land use and other catchment characteristics in each sub-catchment can be assessed. Our use of the rainfall radar data calls into question the validity of using station based data for small scale studies, particularly in urban areas, with high variation apparent in rainfall intensity both spatially and temporally. Variation was particularly high within the heavily urbanised catchment. For water quality studies, high resolution rainfall radar can be implemented to increase the reliability of interpretations of the response of water quality variables to storm water inputs in urban catchments.

Influence of the operation of the Three Gorges Project on wintering waterbird habitats on the East Dongting Lake, China

Yuntao Ye, Shuanghu Zhang, Qiaoqian Han

China Institute of Water Resources and Hydropower Research
Presenter: Dr Yuntao Ye
Type of Presentation: Poster

Abstract
The change of wintering water birds habitat in eastern Dongting Lake area is analyzed based on the water level data in Chenglingji hydrological station, the interpreted remote sensing data, and the ecological habit of wintering water birds in eastern Dongting Lake area. The results show that: The suitable habitat area in eastern Dongting Lake is influenced evidently by the fluctuation of water level, and there is a dynamic transformation relation between water area and suitable habitat area. The water level of 22.29m-25.2m is the optimum water level suitable for wintering water birds survival. After the operation of Three Gorges Project, the water level of the eastern Dongting Lake is lower in wet season, the high water flooded days reduce, the low marshland exposed days in fall increase, which is

beneficial for the growth of low-grassland and increases habitat area and food source of wintering water birds; the water level of the eastern Dongting Lake is higher in dry season, which is beneficial to plant fresh preservation, bud dormancy and seed germination, which can increase food source in habitat. The wetland habitat in eastern Dongting Lake is conducive to wintering water birds to survive after the operation of Three Gorges Project.

The Analysis and Calculation of Target Blue Water Consumption for Sustainable Water Resource

Zhengli Zhai, Xuefeng Sang, Jianhua Wang,Yizi Shang

Institution: China Institute of Water Resources and Hydropower Research
Presenter: Ms Zhengli Zhai
Type of Presentation: Poster

Abstract
Critical to water consumption management is the control of the specific water consumption affected by human activities in the hydrosocial cycle (i.e. target blue water consumption), which is a good approach to control the growth of water usage. In perspective of target blue water consumption, this research work proposes the definition and content of regional target blue water consumption based on the analysis of “blue water” control. Through the identification and analysis of water consumption for various sectors in the hydrosocial cycle, the method for calculating the regional target blue water consumption also is derived based on water balance theory. The city of Tianjin is used in this study as an example. According to the historical runoff, calculations show that the maximum human target blue water consumption under the condition of average annual water supply is 1.91 billion m3. If water consumption is controlled according to these targets, the sustainable development of water resource, economic and social growth, and ecological environment in this region can be expected to be achieved.

Anticancer drugs as water environment contaminants: data needs for quantitative risk assessment

Andre' Brunier

University of Strathclyde
Presenter: Andre' Brunier
Type of Presentation: POSTER

Abstract
Anticancer Drugs are receiving increasing interest by environmental scientists thanks to improved analytical methodologies allowing for concentration detection on the order of ng/l (or less) in environmental samples. These artificial compounds are specifically designed to interact with cells their own DNA. Cytotoxic drugs block cells grown in a precise stage of the growth cycle of rapid development cells like not

only cancer cells, but also hair follicles, bone marrow, stomach and intestines cells. Cytostatic drugs inhibit grown and division of tumor cells, but also interact with other non-target cells, by DNA alteration. Such impact affect immune and reproduction systems of the patient, but it is expected to have similar effects on aquatic organisms. This mode of action is consequently raising concerns about potential risks posed to sensible receptors (both human and ecosystems) for long-term effects of low-concentration exposures as it has been recently shown by studies on selected macro-organisms. Risk assessment is defined as a procedure in which site specific and contaminant specific parameters are used to evaluate risks posed by known hazards to identified receptors. With extant knowledge is not possible undertake reliable risk assessments for anticancer drugs using well-established procedures because fundamental "Fate and Transport" parameters (like diffusion and dispersion coefficients, half-life, retardation factor, etc.) are not available for these compounds. This research aims to investigate how anticancer drugs behaves in the environment by a double approach. On one hand laboratory scale experiments, using seepage and drainage tanks, are under design phase to simulate contaminant flow in different natural porous media. On the other hand, observed data from the experimental phase will be used to calibrate and validate numerical FEM models. "Fate and Transport" parameters, thereby estimated, can be used to predict concentrations of the target anticancer drug(s) using the commonly diffused and accepted risk assessment numerical methods in different scenarios. This research is one of the first attempts to predict anticancer drugs contaminant plume, while several other studies are focusing mainly on anticancer drugs detection and removal in environmental and/or wastewater samples.

Streamflow Prediction in Ungauged, Irrigated Basins

Minghui Zhang Sally Thompson

University of California, Berkeley
Presenter: Minghui Zhang
Type of Presentation: Poster

Abstract
The international "predictions in ungauged basins" or "PUB" effort has broadened and improved the tools available to support water resources management in sparsely observed regions. These tools have, however, been primarily focused on regions with limited diversion of surface or shallow groundwater resources. Incorporating anthropogenic activity into PUB methods is essential given the high level of development of many basins. We extended an existing stochastic framework used to predict the flow duration curve to explore the effects of irrigation on streamflow dynamics. Four canonical scenarios were considered in which irrigation water was (i) primarily sourced from water imports, (ii) primarily sourced from direct in-channel diversions, (iii) sourced from shallow groundwater with direct connectivity to stream channels, or (iv) sourced from deep groundwater that is indirectly connected to surface flow via a shallow aquifer. By comparing the

predicted flow duration curves to those predicted by accounting for climate and geomorphic factors in isolation, specific "fingerprints" of human water withdrawals could be identified for the different irrigation scenarios, and shown to be sensitive to irrigation volumes and scheduling. The results provide a first insight into PUB methodologies that could be employed in heavily managed basins.

Impacts of Flood Pulses on Hyporheic Zones

Liwen Wu Tanu Singh Joerg Lewandowski Gunnar Nuetzmann Anders L E Worman David M Hannah Stefan Krause Jesus D Gomez-Velez4,

Leibniz-Institut für Gewässerökologie und Binnenfischerei
Presenter: Miss Liwen Wu
Type of Presentation: Poster

Abstract
Impacts of flood pulses on hyporheic zones (HZs) vary along river corridors. In the present study we explore systematically the complex interplays among transient flood pulses, geomorphic differences along river corridors, and groundwater upwelling/downwelling. A wide range of site-specific flooding scenarios were applied along river corridors from order 1 to 10 in the presence of groundwater upwelling/downwelling. To evaluate the different impacts of flood pulses on HZs along river corridors impacted by groundwater fluxes, we have choosen the following matrics: hyporheic exchange fluxes, HZ´s extent and depth, and the spatial patterns of residence time and oxic/anoxic zones. Our study reveals that both geomorphic differences along river corridors and groundwater conditions control hyporheic exchange and residence time distributions. Large relative changes of hyporheic exchange flows during flood events often occur in rivers with low order, creating more biogeochemical opportunities that expose surface waters to reactive environments. Ambient groundwater flow constrains hyporheic exchange. Strong upwelling/downwelling can potentially alter hyporheic flow directions and modulate the hydraulic pressure created by flood pulses. Furthermore, the response of hyporheic response to flood recession is a function of river corridor geomorphologies, flood characteristics and groundwater conditions.

Hierarchical interplay of hydrology, community ecology and ecosystem services in the hyporheic zone

Ignacio Peralta–Maraver, Julia Reiss & Anne Robertson

University of Roehampton
Presenter: Ignacio Peralta-Maraver
Type of Presentation: POSTER

Abstract

The Hyporheic Zone (HZ) in streams and rivers has been defined in many ways but a central theme in all definitions is that water exchanges between the open channel and ground water systems. Therefore, knowledge of hydrodynamics is essential for ecologists wanting to understand the flow of energy, cycling of nutrients and pollutants breakdown in the HZ and the whole stream ecosystem. However, this could be challenging because the physical–chemical features of the sediment do not completely explain observed hydrological patterns in the field. Hyporheic sediments also shelter dense and diverse communities (hyporheos) that are closely tied to the flow of water through the HZ. Indeed it has been proposed that a diverse and active hyporheos also promotes the removal of nutrients and pollutants from the water flowing through the HZ. In this review, we describe the hierarchical interplay of hydrology, hyporheos ecology and bioreactor ability of the HZ. We highlight research gaps in our knowledge of community structure, biomass, and production of HZ and we also discuss the multiplicity of variables affecting the bioreactor ability of the HZ and the complexity of mechanisms behind its functioning. We conclude that piecing together the puzzle of hyporheic functioning is only possible through holistic and truly interdisciplinary approaches.

Considering networks in assessment: Integrated evaluation for water management based on ecological networks and the Analytic Network Process

1. Feng Mao 2. Keith Richards 3. Xianfu Zhao 4. Shiyun Chi

University of Birmingham
Presenter: Dr Feng Mao
Type of Presentation: Poster

Abstract
There has been an emerging tendency to evaluate the condition of aquatic ecosystem with a group of criteria, such as biological organisms, physicochemical and hydromorphological quality elements. These multiple criteria are individually assessed and combined into an overall evaluation to support environmental decision making. The existing multi-criteria combination strategies in ecological water quality assessment and management, such as decision trees, multimetric indices, and multivariate methods, have their merits in different circumstances. However, these combination methods mainly rely on the relative importance of each criteria, derived from expert judgement or the correlation of different variables, but neglect the interaction and network of quality elements which are prominent ideas in ecological processes and management. On the basis of the Analytic Network Process (ANP) approach, this research introduces a network-based strategy to combine two sources of information into the construction of integrated water assessment indicators: (1) the weight (relative importance) of each assessment element and (2) the interactions of the elements. With biological, physicochemical and hydromorphological data of 71 sampling reaches obtained in the spring of 2012, the Chishui River Basin in China is used as a demonstrating example. Indicators are constructed with both the conventional and newly proposed approach, while evaluation values of all sampling reaches are calculated using both sets of indicators.

The performance and policy implications of both strategies are then compared and analysed. We argue that the additional information of element interactions helps to construct risk-based indices and improve the ability to detect potential changes of ecological water quality status.

Uptake of differently sized microplastics in gut passage by different species of Daphnia

Suffeiya Supian, John Sadler, Iseult Lynch

University of Birmingham
Presenter: Suffeiya Supian
Type of Presentation: POSTER

Abstract
Plastic-debris, for example from textile weathering and washing, are increasingly accumulating in aquatic-environments, and while they are now recognized as environmental pollutants, their impact on aquatic-ecosystems is not yet fully understood (Jemec et al. 2016). Microplastics, which are synthetic polymers with a diameter smaller than 5 mm and extending down to the nanoscale, have a widespread occurrence and negative effects on different trophic levels have been described (Hollman et al. 2013). Microplastic particles are either directly introduced via sewage discharge or formed by biofouling and mechanical abrasion, making them more prone to consumption by aquatic organisms. As a consequence, they can accumulate in higher trophic levels, although the sources, sinks and depositional pathways are not well documented. It is anticipated that freshwater ecosystems not only act as a source of plastic particles for the oceans, but they may also act, at least temporarily, as a sink (Horton et al. 2016; Nizzetto et al. 2016). We investigated the ingestion and effects of green fluorescently labelled polystyrene microplastics (0.05, 0.5, 5 and 50 μm) on freshwater zooplankton species after 24 and 48 h exposure to a range of mass concentrations (also corrected to compare on the basis of particle number) (Nasser & Lynch, 2016). In the present study, freshwater cladocera of different body sizes within the Daphnia family - D. magna (2.3-5.0 mm), D. pulex (1.9-3.5 mm), D. longispina (1.2-2.5 mm) were selected as candidate organisms, to test the hypothesis that the size of microplastic particles preferentially taken up by the organisms will scale with organism size, due to differences in their gut sizes and filter feeding capabilities. We assessed the uptake and quantitative accumulation, as well as the depuration of the polystyrene microplastics in the aquatic invertebrate Daphnia species using confocal microscopy and fluorescence measurements. Rapid accumulation in the gastrointestinal tract was observed within an hour of exposure to the smaller particle sizes in neonates of all three species. The uptake and effects of polystyrene microplastics on D. magna, D. pulex, D. longspina are presented here for the first time. Bibliography Hollman, P. C. H., Bouwmeester, H., & Peters, R. J. B. (2013). Microplastics in the aquatic food chain; Sources, measurement, occurrence and potential health risks, 32. Retrieved from http://edepot.wur.nl/260490 Horton, A. A., Svendsen, C., Williams, R. J., Spurgeon, D. J., & Lahive, E. (2016). Large

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Long-term changes in macroinvertebrate communities in streams of Denali National Park, Alaska

Eva Maria Loza Vega, Mark Ledger, Alexander Milner

University of Birmingham
Presenter: Eva Maria Loza Vega
Type of Presentation: POSTER

Abstract
Rivers in northern latitudes are sensitive ecosystems which are affected by global change and a key question is: what is the persistence, composition and stability of stream macroinvertebrate communities in a changing climate over longer time periods? The main aim of this project was to examine macroinvertebrate communities over a 20 year period in streams of different characteristics in Denali National Park in interior Alaska to address this question. Temporal and spatial changes in physicochemical variables were examined to investigate changes in the habitat template. PCA and NMDS, using Jaccards and Bray-Curtis measures were used to identify years that were outside the natural variation in the communities over this timeframe and the unstable streams showed the most variation. In addition the role of large climate drivers (e.g. PDO) were examined in determining the community variation. This understanding of long term variation in stream communities is essential if we are to truly understand the role of climate change in these systems.

Riparian evapotranspiration regulates stream hydrology but not nitrogen dynamics in a Mediterranean headwater catchment

Anna Lupon, Susana Bernal, Sílvia Poblador, Eugènia Martí, Francesc Sabater

Swedish University of Agricultural Sciences

Presenter: Anna Lupon
Type of Presentation: POSTER

Abstract
Riparian zones occupy a small area of the drainage area, yet high water requirements by riparian trees can affect catchment water export by reducing stream discharge and promoting the movement of water from the stream towards the riparian zone (i.e., stream hydrological retention). However, the influence of riparian evapotranspiration (ET) on stream nutrient dynamics and exports is still poorly understood. To fill this gap of knowledge, we investigated changes in riparian tree ET, stream discharge, and nutrient chemistry in two contiguous reaches (headwater and valley) with contrasted riparian forest size in a small forested Mediterranean catchment. The temporal pattern of riparian ET was similar between the two reaches and was negatively correlated to net riparian groundwater inputs into the stream (? < -0.55). During the vegetative period, stream hydrological retention occurred mostly at the valley reach (59% of the time), where riparian ET promoted marked diel variations in stream discharge and diminished daily water export by 15%. Yet, daily nitrogen export did not follow the same decreasing pattern because stream hydrological retention was accompanied by in-stream nitrate release and ammonium uptake. These results suggest that well-oxygenated hyporheic zones, high water temperatures, and stocks of nitrogen-rich leaf litter in the streambed could sustain high rates of in-stream nitrification in summer in the studied stream. During the dormant period, when the stream gained water from riparian groundwater, results showed small influences of in-stream processes on stream nitrogen concentrations and exports. Our results highlight that riparian ET can drive stream hydrology at daily and seasonal scales and that in-stream processes are magnified during periods of high stream hydrological retention.

Wetland interfaces in northern peatlands: ecotones in a changing climate

Simon J Dixon (1); Nicholas Kettridge (1); Alexander Hurley (1); Rhoswen Leonard (1); Samantha Probert (1); Kevin J Devito (2); Rich M Petrone (3); Carl A Mendoza (4);
Mike Waddington (5)

University of Birmingham
Presenter: Simon Dixon
Type of Presentation: POSTER

Abstract
Northern peatlands are a vital carbon store, accounting for as much as 30% of the total soil carbon pool. Peat forming mosses sequester carbon by growing in moist conditions, whereas peat decays and releases carbon in unsaturated conditions, the moisture balance in these landscapes is therefore a key driver of their role in the carbon cycle. These wetlands are potentially vulnerable to climate change as a warmer, drier climate leads to lower peat moss productivity, whilst decay increases. These twin effects could lead to positive feedbacks whereby northern peatlands are

turned from a carbon sink to a carbon source. Northern peatlands represent a complex mosaic of landscape units in which ecohydrological functionality, and thus carbon sequestration, is in part dependant on the degree of hydrological connectivity between different areas. In recent years advances have been made in understanding the water balance and landscape function of individual landscape units. However, to date, the interactions between different areas have been largely inferred from field observations and likely water balance excess or deficit in adjacent areas. Understanding the spatial and temporal controls on landscape hydrological connectivity and what form this connectivity takes (water source or water sink) is vital to understand the ecohydrological functioning of northern peatland mosaic landscapes in their entirety, and thus to predicting how climate change will alter landscape function. Conceptual models have been developed for the water balance in boreal peatlands of Alberta, but these have yet to be critically tested with numerical modelling. In this study we address this research gap by conceptualising the hydrophysical and ecohydrological control on water balance across landscape interfaces; focusing on the ecotones between wetlands and upland forests, and between wetlands and ponds. By using two-dimensional unsaturated-flow numerical modelling we show that depending on antecedent conditions water can flow both ways across these interfaces and there is hysteresis between water input to the system and interface response. We also show how surficial geology and climatic setting can control the width and persistence of unique conditions across the interface and so maintain a unique ecotone which is distinct from either environment, and speculate as to how resilient these ecotones will be to a changing climate. Depending on surficial geology and landscape position these ecotones may laterally migrate with expansion or contraction of wetland area, or may be eliminated. The results from this study will be instrumental in helping to understand the ecohydrological function of northern peatland landscapes under a changing climate.

Estimating riverbank residence times and oxygen turnover using (noble) gas tracers

Matthias S. Brennwald Rolf Kipfer

Eawag / ETH Zurich

Presenter: Andrea Popp

Type of Presentation: Poster

Abstract

Water exchange between streams and shallow groundwater in riverbanks drives nutrient and pollutant degradation and is therefore of great importance for water quality. However, most studies assume steady-state conditions despite the fact that riverbank exchanges are highly dynamic. With our study we aim to investigate the variability of residence times in the riverbank and oxygen delivery to the riverbank at a pre alpine stream in Switzerland. The studied stream is severely urbanized except for a 50m stream reach which was restored. The study was conducted at the restored site where the stream has generally loosing conditions under average discharge. Further, the streamwater contains a high nutrient load (P, N) originating from waste water treatment plants. To estimate the oxygen turnover, we

continuously analysed dissolved gas concentrations (O2, Ar, He and Kr) in the stream and in two observation wells (P1 and P5) at the streambank for a period of six months. The noble gases were then used to estimate the overall oxygen input to calculate the oxygen turnover. We employed slug tests to obtain estimates about the hydraulic conductivity of the riverbank at five different observation wells. Additionally, we continuously measured EC, water temperature and water table at the same locations to observe changes during flood events. To estimate the mean residence time, we sampled for ^{222}Rn and $^{3}H/^{3}He$ at P1, P5, in the stream and at several other observation wells within the watershed. Our data shows that (i) under average discharge conditions the water in the streambank is a mixture of young (4 days to 20 days) and older (0.5–50 years) water, (ii) the hydraulic conductivity of the streambank is highly heterogeneous, (iii) major flood events lead to the delivery of oxygen to the aquifer and therefore reduce the residence time in the streambank, (iv) the residence time varies spatially depending on the hydraulic conductivity of the streambank and temporally depending on the stream discharge, (v) the extent of water exchange between stream and streambanks during flood events depends on the intensity and duration of the events. We conclude that under average discharge conditions there is only little exchange between the stream and the streambank due to a clogging layer which prevents infiltration of the stream water to the groundwater. However, increased shear stress occurring during flood events leads to an unclogging of the riverbed which in turn results in increased infiltration of oxygen rich stream water to the groundwater. As a next step we plan to continuously analyse ^{222}Rn during a flood event to investigate the mixing patterns of water originating from the stream and older water from the streambank.

Hydrologic residence time controls the fate of carbon and nitrogen at a lake-groundwater interface

Tyler B. Hampton, Jay P. Zarnetske

Michigan State University
Presenter: Jay Zarnetske
Type of Presentation: Poster

Abstract
Groundwater-surface water (GW-SW) interfaces are important locations for biogeochemical processes, especially the modification of dissolved carbon (C) and nitrogen (N). At GW-SW interfaces, the rates of uptake of these solutes can be orders of magnitude greater than any other place in a watershed, and the rates are controlled by both reaction and transport time scales. Similar to stream GW-SW interfaces, recent investigations of highly permeable lake sediments showed evidence that SW-GW exchange in lakes can significantly modify C and N entering and leaving the lake through groundwater pathways. In particular, the fate of nitrate, a common pollutant to lakes and groundwater, has been correlated to environmental factors such as the quantity and quality of dissolved organic carbon, the abundance of nitrate, and the hydrologic conditions at the GW-SW interface of lakes. To directly test if these factors control nitrate update and transformation, we

conducted a series of in situ experiments that varied reaction substrate and hydrologic residence times in a downwelling lakebed sediments. We used additions of 15N-enriched nitrate as a tracer to tracking of nitrate transformation through denitrification processes under ambient and experimental manipulations (i.e., elevated nitrate, elevated nitrate and labile carbon, and reduced hydraulic head to increase residence times). We also quantified the uptake and modification of dissolved organic carbon and inorganic forms of dissolved N - nitrate, nitrite, nitrogen gas, and nitrous oxide. Under ambient conditions, the lake sediment interface was functioning as location of net production of nitrate (112mg N-NO3- m2d-1). Under experimental conditions of elevated labile carbon (C as acetate), the interface switched from net production to net uptake of nitrate. Under a 1.5mg L-1 increase of labile C the nitrate uptake was 592mg N-NO3- m2d-1, and under 5mg L-1 increase of labile C the nitrate uptake increased to 6 774 mg m2d-1. However, the combination of 5mgL-1 labile C and increasing residence times, by reducing the down-welling rate under lower head conditions, had the greatest impact on the fate of nitrate and overall redox conditions. Under increased residence time and labile C experiment the rate of nitrate uptake was 36 537mg m2d-1. Specifically, denitrification increased 22-fold when residence time was increased. Hence, limitations of overall nitrate transformations are primarily controlled by lake hydrologic conditions at the study site that affect residence time, such as seasonal variations in stage. Forthcoming from this work will be a near-surface geophysical assessment of the less-mobile porosity domain in these sediments to compare with these tracer experimental results, especially the production of 15N-gases via denitrification. We predict that this less-mobile porosity creates important biogeochemical microzones, with longer residence times and different reaction kinetics than we observed in the surrounding bulk-pore fluid domain. These microzones may play a key role in the biogeochemical function of these down-welling sediments, especially in the production of N gases.

Electron donor distribution controls nitrate removal capacity of an unconfined crystalline aquifer

(1) Tamara Kolbe, (1) Jean-Raynald de Dreuzy, (2,3) Benjamin W. Abbott, (4,1) Jean Marçais, (1) Tristan Babey, (5) Zahra Thomas, (6) Stefan Peiffer, (1) Luc Aquilina, (1) Thierry Labasque, (3) Anniet Laverman, (7,8) Jan Fleckenstein, (1) Philippe Boulvais,
(3) Gilles Pinay

OSUR, CNRS, UMR 6118, Géosciences Rennes, Université de Rennes 1, Rennes, France
Presenter: Tamara Kolbe
Type of Presentation: Poster

Abstract
Nitrate contamination of groundwater and surface water causes socioeconomic and environmental problems worldwide. Excess nitrogen that has not been taken up by plants percolates into soils and aquifers, where it can stay for decades. However,

when organic compounds or reduced sulphur is present, denitrification can reduce nitrate to N2O and N2. The rate of nitrate removal can be extremely variable in space and time because of heterogeneity of redox conditions, nitrate sources, and electron donors. Coupled with the fact that direct measurements are difficult in groundwater systems, predicting nitrate delivery from aquifers to rivers is extremely challenging. We investigated the diversity of denitrification rates in an unconfined crystalline aquifer in Brittany, France, where fertilizers has been used for decades. Crystalline aquifers are characterized by heterogeneous flow structures in the upper 40-50 m where weathering processes have created a permeable layer where most groundwater flow occurs. Water chemistry and isotope data from 16 wells revealed that denitrification occurs in a highly spatially variable manner, but that this spatial variation was constant through time. We used a three-dimensional groundwater flow model calibrated against groundwater ages determined with CFC-12 to derive flow structures and transit time distributions throughout the aquifer. We used dissolved N2 excess in groundwater to estimate total nitrate degradation in the aquifer and in combination with transit time distributions to reconstruct nitrate inputs to the aquifer over time. Results demonstrated that denitrification rates are not primary linked to transit times but to the interception of flow paths with anoxic zones, created by abundant electron donors, where nitrate is quickly degraded. Based on these results, we propose that denitrification capacities should be based on the identification of available electron donor sources and locations within the groundwater flow structure. While this approach might not be appropriate for pointwise predictions of nitrate concentrations, it could allow effective estimation of catchment removal and export in regional mass balance.

Groundwater pumping as a salinity mitigation measure to control salt discharge: a case study in a semi-arid small ephemeral catchment in Australia

Sina Alaghmand 1 Hossein Daneshmand 1 Edoardo Daly 2 Matteo Camporese 3 Amin Talei 1

1 Discipline of Civil Engineering, School of Engineering, Monash University Malaysia, Bandar Sunway, Selangor, Malaysia 2- Department of Civil Engineering, Monash University, Clayton, Victoria, Australia 3- Department of Civil, Environmental and Architectural engineering, University of Padova, Padova, Italy

Presenter: Sina Alaghmand

Type of Presentation: Poster

Effective management of river water quality is imperative in the sub-catchment which is the starting point of a drainage network. Arid and semi-arid sub-catchments commonly have an ephemeral flow regime which constitutes only a small portion of the total water balance. Due to a shallow groundwater table, particularly in lowland areas, a significant amount of water evaporates directly from the water table. This may result in an evaporative enrichment in the salinity of the groundwater, which has been occurring in many parts of the world including Australia. On the other hand, a significant fraction of the catchment discharge flux is made up of seepage water in these areas and is thus relatively saline. This paper aims to investigate the impacts of direct groundwater pumping in the interface of

saline and brackish water areas as a feasible and cost-efficient measure to limit the contribution of soluble salts in the groundwater to the surface water. To this aim, a physically-based fully-integrated numerical model has been used to simulate a small semi-arid sub-catchment (0.48 km2) located in south-western Victoria, Australia. MIKE SHE, a fully distributed and physically-based catchment modelling package was utilized to set up, calibrate and validate an integrated model of surface-subsurface water, vegetation transpiration, soil evaporation and solute transport. The results show that in locations where evaporation and root uptake occurs above the capillary fringe, concentrations will be substantially smaller than the discharge water in future. Thus pumping of groundwater in these locations can be implemented to intercept the freshwater for agricultural purposes before joining highly saline areas. Furthermore, a reduction in evapotranspiration, due to relatively lower groundwater table in the lowland, leads to a higher water yield, a smaller solute discharge to the stream at the outlet and less solute accumulation in the unsaturated zone compared to the status que. This could be a viable approach to controlling water quality for small catchments with shallow water table levels where an efficient pumping volume could effectively regulate the catchment flow regime. However, the application should be done with a careful consideration to the ecological consequences of such measure.

Integrated optimal operation of reservoir based on ecological water demand

Fang Guohua
Hohai University, China

Presenter: Fang Guohua

Type of Presentation: Poster

The reservoir blocks the natural river channel, changes the flow pattern, and further causes the change of upstream and downstream of the whole river and estuarine hydrological features. The current reservoirs operation which protects the economic and social development brings some river basin ecological and environmental problems, also results in the serious threat of river ecosystem health. Therefore, the study of reservoir ecological operation is very necessary to alleviate reservoir ecological environment deterioration. This paper defines the connotation of reservoir ecological operation, proposes clearly the ecological operation principles, analyzes ecological operation goal and the classification, and establishes reservoir ecological operation support system, establishes ecological operation model which is as the objective function with the most comprehensive benefit according to the ecological operation goal, analyzes the common model solutions, analyzes the calculation methods of river and reservoir ecological water requirement at home and abroad, considers reservoir ecological water requirement calculation in periods of time, takes the example of Wanjiazhai reservoir in Yellow River, China as case study, which solves optimized operation model by meeting the minimum ecological flow and suitable ecological flow, compares and analysis the results, reaches a conclusion that reservoir optimized operation considering ecological constraints has the influence on generated energy, but the damage to

economic benefits is limited, also this partly damage changes into ecological benefit and it has important significance to the stability and coordination of ecological system.

Interface of fluorite with shallow water aquifers in parts of India, its health implications and remediation techniques

Dr.S.K.Sharma

Carman Residential and Day School
Presenter: Dr.S.K.Sharma - Head of Geography and Environmental Science Department
Type of Presentation: Poster

Abstract
Fluoride problems are wide spread in India. Hydrochemical investigation from the shallow subsurface water aquifers up to a depth of 50m has been investigated in nine effected states of the country in order to find out the source and mechanism of fluoride release into groundwater and to understand groundwater hydrochemistry. A total of 1360 subsurface water sample were analyzed to determine the fluoride content in water. The analyses indicate the fluoride concentration range from < 0.2 to 13.2ppm. The statewise analyses shows the variation from <0.2 to 2.0ppm in Jammu & Kashmir ; <0.5ppm in Himachal Pradesh ; >6.5 ppm in Rajsthan ; 0.2 to 0.6ppm in Haryana ; 0.35 to 4.0ppm in Bihar : 5 to 12ppm in Chattisgarh ; 2.7 to 6ppm in West Bengal ; 8.2 to 13.2ppm in Orissa and 2.7 to 6.0ppm in Maharashtra. Among the various minerals responsible for high concentration of fluoride, the flour - apatite [3Ca 3 (PO 4) 2], calcium difluoride [CaF2] and fluorite, CaF2 are important. However, in the present study, the most important being the Fluorite, CaF2 and the leaching of fluoride from the metamorphic rocks hornblende gneiss of Proterozoic age. Concentration of fluoride below 1.5ppm according to World Health Organization (WHO) are helpful in prevention of tooth decay, and also assists in the development of perfect bone structure in human and animals. But a concentratio above 1.5ppm in water is manifested in the form of 'endemic fluorosis' causing tooth mottling inducing the prevalence of osteoporosis and collapsed vertebrae. Fluorosis has no known treatment other than early detection and limiting the amount of fluoride ingested. High fluoride consumption leads to the deadly fluorosis of the bones which is generally found in Asian region but it is more acute in India. Possibilities of reducing the high fluoride content of groundwater by defluorination process / dilution with the surface water is one very simple existing technique. But addition of Ca++ ions to solution in contact with fluorite when experimented in distilled water caused appreciable decrease in fluoride concentration which appears to be more suitable solution to high fluoride rich water areas. Easily available local raw materials, such as gypsum, clay, serpentine and marble is also used to reduce the fluoride content. In-situ treatment has received much less attention. Alkaline soils can be remedied through the application of gypsum, pyrite and sulphuric acid.

Gypsum treatment is the classical method of alleviating the soil alkalinity. It has an advantages of being cheaply and abundantly available in India. The only problem with the treatment is that it gives a harder water. The permissible SO4 content would be exceeded and accepting such water by the population might pose a problem. But this may be an advantage as the higher intake of ca++ will mitigate the effect of F-. On the basis of recent research, the planting of poplar trees (populus deltoids) as a part of agro and social forestry have been taken up in Haryana state and it has shown encouraging results in alleviating sodicity in soils on a long term basis.

Experimental study on the evolution of sheet flow in rolling waves on a slope surface

ZHAO Yong YANG Miao WANG Ying WANG Hao

Institute of Water Resources and Hydropower Research
Presenter: Dr Jiaguo GONG
Type of Presentation: Poster

Abstract
The shallow open channel flow on slope is a common form of confluence in nature, and its dynamic process is always a research emphasis and difficulties in water cycle, which is also the scientific foundation of pollutant dispersion and sediment transport on slope. Traditional water cycle researches put focus on the process of slope-runoff yield and concentration of channel, but little research on concentration of shallow flow, especially lake of research on the observation experiment, dynamical characteristic, dispersion law and energy dissipation of concentration of shallow flow. Hydraulic and instability characteristics of thin-layer flow on 5 slope gradients with 21 discharges per unit width were studied in variable-slope flume experiments with an ultrasonic measurement technique. The results show that the mean flow index on the slope was 0.536. The flow regime was mainly turbulence and the flow pattern appeared as a torrent. On the rough bed surface, with increase of water amount, the flow evolved as instability, roll wave quenching, and secondary instability. The critical flow of roll wave quenching decreased with increase of the slope gradient between critical Reynolds numbers 509 to 602. With increase of flow distance, the wavelength and wave height increased. The frequency decreased gradually and merging of the roll waves could be seen during the process. When the flow rate of unit width and slope gradient increased, so did the wave speed and frequency, but the wavelength changed little. The wave height showed a parabolic tendency of initial increase and then decrease.

Effect of water level fluctuation at Victoria reservoir, Sri Lanka on water level of wells located closer to the reservoir

Wickramasooriya A. K. Rajapaksha R. W. M. N. S.

Department of Geography, University of Peradeniya, Sri Lanka

Presenter: Ashvin Wickramasooriya
Type of Presentation: Poster

Abstract
Water level of wells can fluctuate because of changes in water level of a reservoir specially which are located drown stream and close to the reservoir. Main aim of the study was to identify the relationship between the water level fluctuation of a reservoir and how it will effect on water levels of dug wells closer to the reservoir. To achieve this task Wewegama village which is situated closer to the Victoria reservoir was selected. The measurement of water levels of reservoir and dug wells were taken at each weekend for six months from May to October in 2016. Water levels of reservoir were collected data from Mahaweli Authority of Sri Lanka while water levels at ten dug wells were measured during fieldwork. Depths to water levels of ten dug wells were plotted weekly to study the water level distribution in the study area. Using GPS coordinates of ten dug well locations, distances to dug wells from the reservoir are calculated. Water level at dug wells were plotted against the distance to the reservoir to understand the relationship between distance to the reservoir and the depth to water table. According to these graph there is a positive correlation can observe between distance to ten dug wells and the depths to water levels. Also it was noted that with the variation of reservoir water level, water levels of dug wells also varies accordingly. Well no 2 , well no 8 and well no 10 have recorded the maximum depth to water level throughout the study period. Bothe well no 8 and well no 10 are located far away from the reservoir. However, well no 2 has recorded higher depth to water table because it is located little higher elevation compared to other wells. According to the results of this study it can be conclude that there is a direct relationship between distance to the dug wells from the Victoria reservoir to dug wells and depth to their

Assessment of potential drought refuges in the Upper Ovens River (Australia), based on UAV Thermal Imagery

1. Roser Casas-Mulet 2. Dongryeol Ryu 3. Michael Stewardson

The University of Melbourne / Water Research Institute, Cardiff University
Presenter: Dr Roser Casas-Mulet
Type of Presentation: Poster

Abstract
The Upper Ovens River (Australia) has highly connected groundwater and surface water resources. It is one of the last major rivers in the Murray-Darling Basin which retains a near natural flow regime and supports high ecological values. Although largely unregulated, consumptive demand in dry years has the potential to significantly reduce or stop flow. One key environmental goal in the Upper Ovens is to reduce the risk to aquatic life during critical low flow periods by restricting surface water and groundwater diversions. While the importance of protecting the ecological values of the upper Ovens River under extreme low flows is recognised, there is little understanding of the natural capacity of the Upper Ovens System to

promote thermally differentiated (cold-water) areas acting as drought refuges during periods of low flow. By using drone-based thermal infrared (TIR) imagery combined with aerial photography and point-water quality data, we aim at assess drought refuge potential in the Upper Ovens River between Bright and Myrtleford (? 50 km) during extreme low flows in summer. We will produce combined aerial and ground-based datasets to address three main objectives: (i) to identify spatial patters of thermal heterogeneity, (ii) to assess the occurrence and distribution of potential drought-refuges, and (iii) to assess the extent of groundwater dominance in such areas. The surveys will be carried out in February 2017 and preliminary results will be available shortly after that. We expect to find a clear pattern of thermal heterogeneity link with groundwater influxes linked to fluvial geomorphology features. These finding will support the development of monitoring strategies to support the effectiveness of the Upper Ovens 2012 Water Management Plan.

Deuterium and O-18 as tracers for lacustrine groundwater discharge

Jörg Lewandowski, Franziska Pöschke, Karin Meinikmann

Leibniz-Institute of Freshwater Ecology and Inland Fisheries
Presenter: Jörg Lewandowski
Type of Presentation: Poster

Abstract
Different tracers are used in ecohydrology to study transport processes across groundwater-surface water interfaces. The stable water isotopes oxygen-18 and deuterium as parts of the water molecule are valuable tracers since their behavior in aquifers is conservative. Isotopic signatures of groundwater and surface water differ due to the impact of evaporation on lake water. Stable isotope measurements are nowadays orders of magnitude cheaper, faster, and easier due to the recent development of cavity ring-down spectroscopy. Based on that analytical progress, we suggest a much broader use and highlight a number of promising ecohydrological applications in studies of lacustrine groundwater discharge. For example, they might be used to clearly distinguish between in- and exfiltration zones of lakes, to identify temporal fluctuations of in- and exfiltration, but also to identify sampling artifacts due to short circuits during sampling with lakebed piezometers.

Small-scale bioturbation has severe impacts on entire ecosystems

Jörg Lewandowski, Franz Hölker, Viktor Baranov, Michael Hupfer

Leibniz-Institute of Freshwater Ecology and Inland Fisheries
Presenter: Joerg Lewandowski

Type of Presentation: Poster

Abstract
Tube-dwelling organisms such as chironomids pump large water volumes through their burrows in the sediment. For shallow lakes we could show that volumes equivalent to the whole water body can be pumped through the tubes on time scales of days to weeks. Filter rates of the chironomids are in the same order of magnitude as those of zooplankton. Intermittent pumping by macrozoobenthos introduces oxygen into anoxic sediment layers and creates a dynamic, three-dimensional mosaic of different redox conditions and zonations. Bioturbation is a major driver of aquatic sediment respiration. Hotspots of element cycling occur at the oxic-anoxic interfaces controlling the fate of organic matter and nutrients in shallow aquatic ecosystems as well as fluxes of nutrients (N, P) between sediment and overlying water. Chironomids modify P burial, the stoichiometry of nutrients in the water body and thus alter the trophic state of lakes. Therefore, we postulate that chironomids are small but abundant 'ecosystem engineers' exerting high filter-feeding pressure and affecting biogeochemical processes from the micro scale to the ecosystem scale, especially in shallow lakes ecosystems. Figure taken from Hölker et al. (2015, Ecological Monographs, 85(3), 333–351): Mechanisms by which tube-dwelling invertebrates may control water quality and trophic status (Chironomus plumosus larvae used as an example for tube-dwelling invertebrates).

Environmental Impact of Leachate Pollution on Groundwater Sources in Ikere Metropolis, Ekiti State, Nigeria

Edward, Josephine Bolaji and Babalola, Titilayo Mary

Ekiti State University, Ado-Ekiti, Ekiti State, Nigeria
Presenter: Dr Bolaji Edward
Type of Presentation: Poster

Abstract
The physical, chemical and bacteriological analyses of water samples from three wells located near landfill site at Ayetoro quarters, Ikere-Ekiti, Ekiti State, Nigeria was carried out to ascertain the magnitude of dumpsite pollution on groundwater quality in the area. Borehole locations were at radial distances of 20m, 50m, and 90m respectively away from the landfill site. The physicochemical parameters were determined using conventional equipment and standard laboratory procedures of APHA (1998). The parameters determined included Temperature (28.170C), pH (7.21), Conductivity (166.63µSm), Dissolved Oxygen (0.62 mg/L), Total dissolved solids (43.42 mg/L), Total suspended solids (155.44 mg/L),Total hardness (47.42 mg/L), Total suspended solid (155.44 mg/L), Nitrate (0.62 mg/L), Nitrite (0.46 mg/L), Chloride (19.44 mg/L), Magnesium (36.65 mg/L), Calcium (10.77 mg/L), Phosphate (357.73 mg/L), Sulphate (272.73 mg/L), and the metals, Chromium and Copper were not detected in all the samples analyzed. Most of these parameters indicate traceable pollution but were below the World Health Organization (WHO) and the Nigeria Standard for Drinking Water quality (NSDWQ) limits for

consumption. Bacteriological examination revealed severe pollution in all the wells. Statistical analyses also indicated significant differences among all the parameters tested at 95% level of probability. Public enlightenment on waste sorting, adoption of clean technology and the use of sanitary landfill to prevent further contamination of groundwater flow should be encouraged. Key Words: Impact, Leachates, Pollution, Groundwaters, Ikere-Ekiti.

Landuse and Groundwater Chemistry in an Urban Settlement in Nigeria

Adebayo Oluwole ELUDOYIN 2. Charles Tolulope AJAYI

Department of Geography, Obafemi Awolowo University, Ile-Ife, Nigeria
Presenter: Dr Adebayo Eludoyin
Type of Presentation: Poster

Abstract
Freshwater supply is important for the survival of man. Many developing countries are however characterised by poor water supply. The main water sources in a typical urban area in the southwest Nigeria - typical of many developing countries - are rain and groundwater sources. This study assessed the quality of rain and groundwater in an urban area in southwest Nigeria. The study investigated the chemical characteristics of rainfall and groundwater sources in the area and assessed the influence of land use on the quality of the groundwater in the metropolis. It further determined whether the quality of the rain and groundwater for domestic and agricultural uses in the area. Water samples were taken from groundwater sources, and analysed for selected ions and heavy metals as we as pH, water temperature and conductivity. The results showed that the rainwater in the area is dominated (in absolute weight) by Cl-, CO3- and Ca2+ and that the sum of selected cations are relatively higher at the industrial areas than the other areas. The groundwater sources are generally characterized by weak acidity to almost neutral pH (5.8-7.8) values, Cl- (120-720 mgl-) for, Ca2+ (0.1-59.2 mgl-) and E.C values (48-1034μScm-1). Most of the investigated results (especially conductivity, CO3-, NO3-, Cl-, SO42-) occurred in significantly higher concentration in the hand dug wells than the borehole wells. The quality assessment indicated that the concentration of Cl- in the hand dug wells and boreholes as well as Mn in the rainwater exceeded the acceptable limit guidelines of the Nigeria Water Quality Standards, World Health Organisation and European standards and are therefore considered unfit for consumption and market gardening. The study showed significant relationship between landuse and water quality in the area

Are ecological and hydrological dynamics important in modelling ecohydrological processes?

Alicia García Arias (1) Guiomar Ruiz-Pérez (2) Félix Francés (1)

Universitat Politècnica de Valencia - Research Institute of Water and Environmental Engineering
Presenter: Dr Alicia García-Arias
Type of Presentation: Poster

Abstract
Traditionally, hydrological models have included the effect of the interception and evapotranspiration without considering plant dynamics. On the other hand, it is not common to include all the main hydrological processes when modelling plant behaviour. Fortunately, nowadays many authors have recognized the importance of linking the hydrological and ecological dynamics. In fact, there is a trend of including the pivotal role of the vegetation for a better understanding of how plants affect the hydrological systems, as well as how the water balance and the hydraulic impacts control plants behaviour in water dependent ecosystems. This contribution aims to demonstrate that better results are possible when modelling ecological and hydrological processes by dynamic and interconnected approaches, independently of the modelling objective (hydrological or ecological results). Through several modelling approaches, implemented in different case studies we prove this affirmation. The implementation of a hydrological model in an experimental plot allows the comparison of the results including and neglecting the role of plants. In addition, we tested two riparian vegetation models in a river reach where both models have demonstrated to provide good results. The river reach presents riparian and terrestrial bands of vegetation. The main difference between models is precisely the consideration of hydrological dynamics in the system and the use of the different water sources by the vegetation. Both the experimental plot and the river reach are under similar semi-arid conditions in order to assure that water is the limiting factor for plants development. Results demonstrate that prediction capabilities increase when the modelling of the soil water balance takes into account main ecological processes.

Geothermal field studies using stable isotope hydrology : case studies in Algeria

HOUHA Belgacem MOUHAMEDI Mohamed redha SEDRATI Abdenour

University of Khenchela, Algeria
Presenter: Mr Hichem CHENAKER
Type of Presentation: Poster

Abstract
To improve our understanding of the origin of thermal water from North-Eastern Algeria, hydrochemical facies, isotopic characteristics and identify the major geochemical processes that affect water composition, for this purpose, a multidisciplinary approach was adopted, including hydrogeochemistry, isotope hydrology and principal component analysis (PCA). Eleven samples collected from thermal springs in 2015 vary in temperature between 38 and 96 ?C, a near neutral

pH and very high values of electrical conductivity. Two groundwater types were identified: highly mineralized Na-Cl type representing the deep thermal waters and Ca-SO4 type determined the presence of evaporite deposits (Triassic) along the circuit of upwelling. The application of IIRG method illustrates three rectangular configurations which the first corresponds perfectly to the standard diagram ?, indicating a deep circulation of fluids, second corresponding to water circulation through the evaporate sequences, and the last belongs to intermediate between the standard a and ?, due to possible mixing in thermal waters with surrounding groundwater. The isotopic results (d O18, dD) (respectively -9.95 to -7.72 ‰ and from -61.99 to -38.20 ‰) fall on the Global Meteoric Water Line (GMWL) indicate a meteoric origin of the thermal water (rains at higher altitude). In order to know the state of fluid-mineral equilibrium, saturation index (SI) was used; the most of the thermal waters have Chalcedony and quartz near or slightly above the saturation limit for equilibrium. In present study, multivariate statistical method - Principal component analysis PCA - is used; PC1 (41%) explains the minerality, (ionic composition), for which temperature is of secondary importance PC2 (18%).

SEASONAL EFFECTS ON HYPORHEIC AND WHOLE STREAM ATTENUATION OF POLAR ORGANIC TRACE COMPOUNDS IN AN URBAN STREAM IN SOUTH AUSTRALIA

JONAS L. SCHAPER[1,4], KARIN MEINIKMANN[1], MARGARET A. SHANAFIELD[2], EDDIE W. BANKS[2], ANJA, HOEHNE[4], MALTE POSSELT[3], ANKE PUTSCHEW[4], GUNNAR NUETZMANN[1,5], OKKE BATELAAN[2] AND JOERG LEWANDOWSKI[1,5]

[1] Leibniz-Institute of Freshwater Ecology and Inland Fisheries, Department Ecohydrology, Müggelseedamm 310, 12587 Berlin, Germany
[2] National Centre for Groundwater Research and Training, Flinders University, Adelaide, South Australia, Australia
[3] Department of Environmental Science and Analytical Chemistry (ACES), Stockholm University, Sweden
[4] Technical University Berlin, Department of Water Quality Control, Strasse des 17. Juni 135, 10623 Berlin, Germany
[5] Humboldt University Berlin, Geography Department, Rudower Chaussee 16, 12489 Berlin, Germany

Presenter: Jonas L. Schaper
Type of presentation: Poster

In urban streams, hyporheic zones have been identified as a major sink for wastewater treatment plant derived trace organic compounds (TrOCs). However, the relative contribution of hyporheic zone attenuation of TrOCs compared to the overall whole stream attenuation at the reach scale (kilometers) has not been quantified in-situ. The hydrological and seasonal factors that control TrOC attenuation in the hyporheic zone and at the whole stream scale are not known.
In the present field study we investigated the fate of 20 TrOCs in both surface water and hyporheic porewater under winter conditions in an urban stream in Adelaide, South Australia. A salt tracer injection test was conducted and evaluated using OTIS-P to quantify transient storage and physical stream transport parameters. In the surface water, time integrated sampling was used to quantify first-order attenuation rates between different stream reaches. Minipoint porewater sampling in the hyporheic zone was combined with active heat pulse sensing to quantify attenuation

of TrOCs in the hyporheic zone at ten sites distributed along the stream reach. A 1D-advection dispersion model was used to calculate first-order attenuation rates from both porewater and surface water samples using the transport parameters provided by heat pulse sensing and OTIS-P, respectively. A similar set of experiments has been conducted under summer conditions in March 2017, to test the effects of stream temperature and different hydrological conditions on TrOC in stream turnover.

Damkoehler numbers, first-order attenuation rates within the hyporheic zone and at the reach scale as well as tracer test derived transient storage parameters are used to quantify the proportion of hyporheic attenuation relative to the whole stream attenuation rates under both summer and winter climatic and hydrological conditions. The outcomes strengthen our understanding of the fate of TrOCs in lotic systems and highlight the important role of the hyporheic zone as a main sink for wastewater treatment plant derived pollutants in urban streams.

Travelling to the venue

1. **Conference venue and important places**

Centre for Professional Development

The HydroEco 2017 conference will be held in the Centre for Professional Development (CPD), which is situated in the College of Medical and Dental Sciences, University of Birmingham. It is just a three minutes' walk from University train station.
Website: http://www.birmingham.ac.uk/facilities/mds-cpd/contact/index.aspx

Lapworth Museum of Geology

The Lapworth Museum is located within the Aston Webb A Block building just off the Ring Road South.
Website: http://www.birmingham.ac.uk/facilities/lapworth-museum/index.aspx

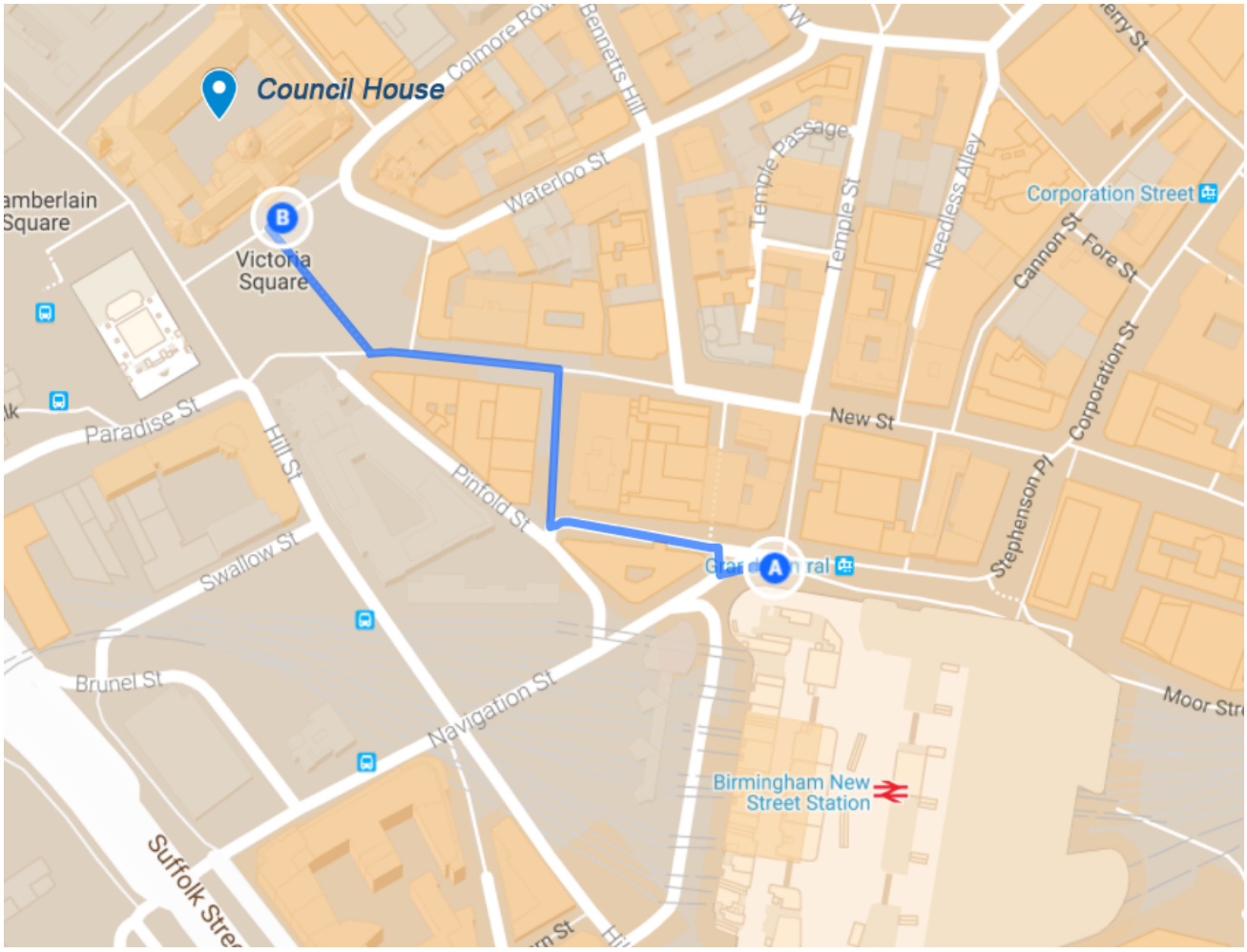
Venuebirmingham

The reception of Venuebirmingham Hotel can be found at Lucas House, 48 Edgbaston Park Road, Edgbaston, Birmingham, B15 2RA. There is a 15 min walk from the University station to the hotel.
Website: http://www.venuebirmingham.com

More detailed university maps can be found via:
http://www.birmingham.ac.uk/contact/directions/map.aspx

Council House

The HydroEco2017 conference dinner will take place on Wednesday 21nd June 2017 at Birmingham's beautiful Council House, which is in the city centre of Birmingham at 1 Victoria Square, Birmingham, B1 1BB. It takes about 5 min walk from New Street Station to the Council House.



2. Directions from Birmingham City Centre

The fastest way to travel from the Birmingham city centre to the University of Birmingham is by train. There are regular trains connecting these two places – Birmingham New Street Station in the city centre, and University Station at the University. The train frequency during Monday to Saturday is about 5-10 min, and on Sunday is about 15-30 min. The travel time is about 7 min.
For detailed rail information, please visit: http://www.nationalrail.co.uk/.
There are also taxi stops outside Birmingham New Street Station.

3. Directions from Birmingham International Airport

There are many trains an hour departing from Birmingham International Airport to Birmingham New Street. The travel time is 10 – 20 mins.
At Birmingham New Street, take the train or taxi to the University.
For detailed rail information, please visit: http://www.nationalrail.co.uk/.

4. Directions from London Heathrow Airport

You will need to take London Underground from Heathrow terminals to the city centre. Trains from London to Birmingham depart from two stations – London Euston and London Marylebone.

From London Heathrow to London Euston Station

Option 1: Take the Piccadilly line (dark blue), and transfer at Green Park, then take the Victoria line (light blue) to Euston.
Option 2: Take the Heathrow Express to Paddington Station, take the Bakerloo line (brown) at Paddington to Oxford Circus, then take the Victoria line (light blue) to Euston.

From London Heathrow to London Marylebone Station

Option 1: Take the Piccadilly line (dark blue), and transfer at Piccadilly Circus, then take the Bakerloo line (brown) to Marylebone.
Option 2: Take the Heathrow Express to Paddington Station, then take the Bakerloo line (brown) to Marylebone.
The Heathrow Express is faster but more expensive.

There are many trains an hour from London to Birmingham (London Euston to Birmingham New Street, or London Marylebone to Birmingham Moor Street). The travel time is roughly 1h30m-2h30m. Booking train tickets in advance between London and Birmingham can save quite a lot of money, but you can only use the ticket on the train you specified in advance. New Street and Moor Street stations in Birmingham are connected by trains, and they are within a walking distance about 5 min.

Some useful travel websites:

London Underground: https://tfl.gov.uk/modes/tube/

Heathrow Express: https://www.heathrowexpress.com/

National Rail: http://www.nationalrail.co.uk/

University's 'getting here' page:
http://www.birmingham.ac.uk/contact/directions/getting-here-edgbaston.aspx